POWER

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Who Should Own the Coal Mines?

WE MADE a false start when we allowed the discoverer of a natural resource to appropriate it for himself and his heirs and assigns to have and to hold for all time.

We are having borne in upon us very convincingly what a stupendous mistake it was in the case of coal.

The manufacture, transportation and distribution of most of the essentials of modern life depend upon coal, and the nation's supply is in the private ownership of a group that has demonstrated its utter inability or unwillingness to develop that supply with a dependableness that will stabilize industry and assure the comfort and well-being of the people, at a price commensurate with the service rendered.

It is difficult to justify a system whereby the man who discovered or bought or inherited a coal mine gets several times as much per ton for the coal as does the miner who actually goes down into the bowels of the earth and risks his life in getting it out; in which the owners of the nation's fuel supply can mine it or not when and how they please, sell it at any price they can command and tell a congressionally constituted body that it is none of its business how much or how little they mine or how much or how little it costs to do it.

But this is the situation.

Under our customs and our constitution their vested rights are inviolable. There must be no confiscation, either of the money that they have invested in developments or even of the title to the natural resources that they have appropriated.

But a systematic, co-ordinated administration of the country's fuel supply is as essential to the national well-being as is the maintenance of a dependable and suitable water supply to a city.

Even if the nation should be obliged to buy back the coal mines which it has allowed to be taken and to pay $4,500,000,000 for them and the improvements that have been put into them and the claims with which they have been charged, as proposed by Mr. Golden, this would make an annual interest and sinking fund charge of less than half a dollar per ton of our usual output.

And this is a heap less than we are apparently being mulcted out of now by ineffective individualism.

F. R. Low

Northwest Station Increasing Stoker Capacity

FORCED-DRAFT chain grates replacing natural-draft stokers give the increase in the steam supply desired. Operation normally is at 200 per cent of rating and 300 per cent during peaks. Ordinary daily range in combustion rate is from 35 to 50 pounds of coal as fired per square foot of grate per hour with an extreme maximum up to 55 pounds.

OWING to its rapidly increasing load the Commonwealth Edison Company, of Chicago, has had difficulty in meeting peak demands. There are times when every available unit must be operated, and in some of the stations, during the peak hours, lack of steam has made it impossible to secure the full generating capacity. This has been true particularly at the Northwest Station, where six units having an aggregate capacity to generate 180,000 kw. are installed, although the nominal rating is somewhat less. Two of these units are of the old Curtis vertical type, each rated at 20,000 kw., and the other four are horizontal machines capable of delivering individually 35,000 kw. Each of the units is supplied with steam by its individual row of boilers. There is no cross-connection between units, but the usual practice is to supply steam to each turbine from its respective boilers.

In the original installation, consisting of units Nos. 1 and 2, there are ten boilers per unit, each containing 5,600 sq.ft. of steam-making surface and equipped with natural-draft chain-grate stokers having an active area of 115 sq.ft. and bearing a ratio to the heating surface of 1 to 48.7. Economizers were not installed, and in this section of the building lack of headroom would prohibit their use at the present time. In all later boiler installations in the station continued use was made of the chain grate, and with the exception of unit No. 3 economizers were installed and induced draft provided. These boilers are of the cross-drum type and all of the same size, each with 12,200 sq.ft. of surface and served by two stokers. In units Nos. 3 and 6 there are five boilers per unit, and with two stokers per boiler, 10.5 ft. wide and 14.5 ft. long, the active grate area is 304.5 sq.ft., which bears a ratio to the steam-making surface of 1 to 40. In units Nos. 4 and 5 stokers 10.5 ft. wide and 13 ft. long gave 273 sq.ft. of grate area per boiler, or 1 sq.ft. of grate to 45 sq.ft. of steam-making surface.

FIG. 1—NO. 4 ROW OF BOILERS, NORTHWEST STATION, EQUIPPED WITH FORCED-DRAFT STOKERS

To meet the demand in the station for more steam, it was finally decided to install forced-draft chain-grate stokers under the boilers of units Nos. 4 and 5. With no economizers for the first three units and the draft for unit No. 3 relatively low, a similar conversion was not warranted, and by reason of the large stokers and high induced draft for the boilers in unit No. 6, it is doubtful if any change will be made here. In any event it is probable that the new stokers will not only supply all the steam needed for their respective turbines, but provide a surplus sufficient to tide over any shortage from the other boilers.

From the new forced-draft installations higher efficiency is anticipated and generally better results from the poor grade of coal used at the station. This is central Illinois coal running from 9,500 to 10,200 B.t.u. per lb., as fired, with 3.5 per cent sulphur, about 14 per cent ash and a moisture content of 13 per cent, increasing to 15 per cent when the moisture added at the station is included.

At the time of writing, replacement is under way in row No. 5, but in row No. 4 the work has been completed and the new stokers are in operation. All ten stokers under the five boilers are Illinois type G forced-draft chain grates, 9.5 ft. wide and 15 ft. long, with an aggregate area per boiler of 285 sq.ft., which to the steam-making surface bears a ratio of 1 to 42.8. The stokers are set under the low end of the boiler, the headroom being 9 ft. 5 in. from the floor to the bottom of the front-tube header. As in the new installation at Fisk Street Station, the boiler setting is recessed under a sloping bridge wall. The stokers carry back to the rear wall, which is provided with inspection doors and I-beam supports to take the weight of the upper portion of the wall. Waterbacks connected into the boiler

circulation protect the bridge walls, and ventilated tile at the clinker line afford protection to the side and center walls.

As the first pass is at the rear, a furnace roof of C tile is laid on the first row of tubes. In an attempt to stop the leakage of furnace gases through the roof, sealing tile were placed over the C tile, and to make room for such construction it was necessary to remove the second row of tubes all the way across. The vertical baffles between the first and second passes with which the boilers had been equipped were replaced by Turner sloping baffles to make the passages conform with the reduction in temperature and volume of the gases.

Suspended arches of the new Liptak radial end type are provided to afford better protection to the steel supports at the heel of the arch, where protection is most needed. At the gate a 12-in. radial ignition arch is another of the late features adopted in this construction. The main, or fire, arch is 9 ft. 6 in. long and has a rise from 3 ft. 6 in. above the grates at the front to 4 ft. 2 in. at the rear.

A furnace volume of approximately 3,000 cu.ft. is available. This is a provision of 10.5 cu.ft. of furnace volume per square foot of grate area, or, roughly, 0.21 cu.ft. per pound of coal burned at a combustion rate of 50 lb. of coal per hour per square foot of grate.

During off-peak hours the boilers generate from 60,000 to 70,000 lb. of steam per hour, this being roughly equivalent to operation at 200 per cent of rating and requiring a combustion rate approximating 35 lb. per square foot of grate per hour. During the peaks the steam supply is run up to 100,000 lb. per hour and the combustion rate ranges from 50 to 55 lb. per square foot of grate to maintain operation in the vicinity of 300 per cent of rating. Thus the ordinary daily range in combustion rate is from 35 to 50 lb. of coal per hour per square foot of grate, with an extreme maximum of 55 lb.

When operating at the higher ratings, the practice is to carry a 7-in. fire and air pressures of 0.1 in. in the first zone, 1 in. in the second and third zones, which are operated in parallel as one zone and therefore carry the same presures; 0.7 in. in the fourth and fifth zones, also operated in parallel; 0.4 in. in the sixth zone and 0.1 in. in the seventh zone. The air pressures are, of course, varied to suit the load, but for the different zones they always stand in about the same relative proportions.

As will be inferred from the previous paragraph, the stokers have seven zones of equal length, spaced on 24-in. centers, the second and third; and the fourth and fifth being operated in parallel, that is, supplied with air at the same pressure, so that in reality the stoker is operated on the five-zone basis, the two central zones being twice as long as the others.

A number of new features have been incorporated in these stokers. The semicircular steel tuyeres usually found in Illinois stokers have been replaced by cast-iron hopper-bottom tuyeres made of an inverted V-type casting, the lower edges of adjacent castings forming the opening at the bottom of each compartment. At the bottom of each of these compartments there is a hinged door that extends across the entire width of the stoker. Both the lower edges of the V-castings and the surface of the cast-iron door are machined so as to give an airtight joint. The ends of the castings are machined as are the inside surfaces of the side frames, thus forming an airtight compartment.

From the bottom door of each compartment an operating shaft extends through the outside of the boiler wall, and by means of a lever, segment and retaining dog the door is held tight against the bottom edges of the castings. Releasing the lever allows the door to swing open by its own weight, and accumulated drippings are dumped onto the returning chain, where the fine particles pass through the lower strand of chain

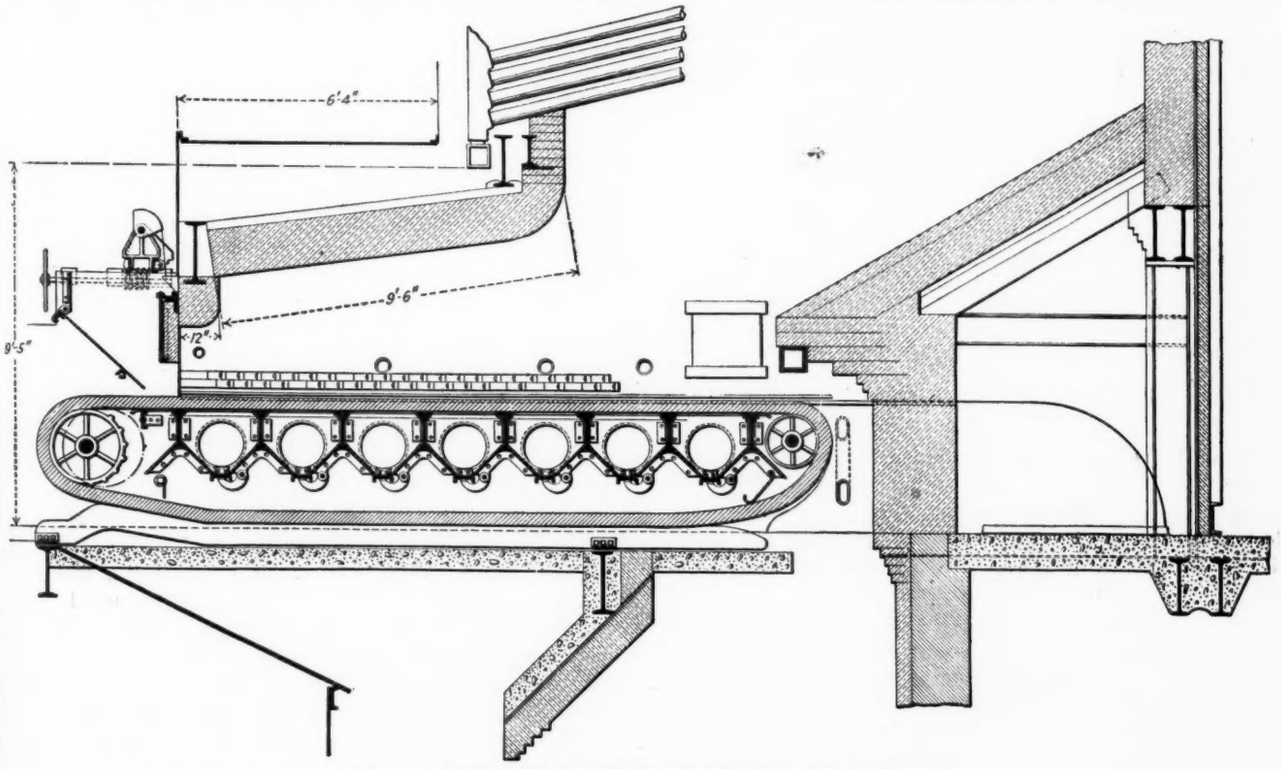


FIG. 2—LONGITUDINAL SECTION THROUGH FURNACE

into the green-coal hopper underneath, which extends nearly the full length of the stoker. The coarser particles are carried forward to the front and dropped through to the floor in front of the stoker as the chains open up in passing around the driving sprockets. In actual operation these drippings are dumped once every eight hours. This arrangement for the removal of siftings is particularly simple, as by its use the necessity for providing systems of piping for blowing out the accumulated drippings is done away with, and it also eliminates the dust common to stokers which continuously drag the siftings and ash from the compartments to the front of the stoker.

Other advantages of the new design may be attributed to the use of cast iron instead of steel for the tuyeres. If the accumulation of drippings is allowed to catch fire, it will have little effect on the cast iron,

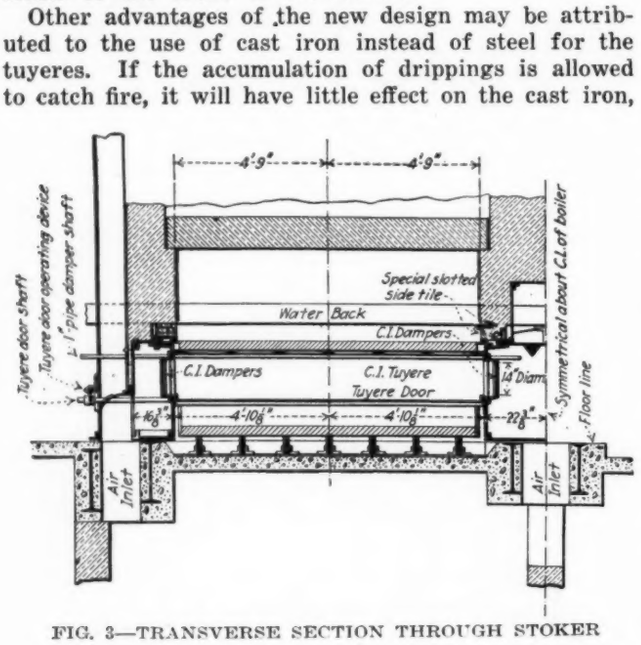


FIG. 3—TRANSVERSE SECTION THROUGH STOKER

which would not be true of the steel. Eliminating the use of steam or air piping for blowing out the drippings, as stated previously, also obviates the formation of a weak sulphuric-acid solution formed from the condensation from the steam or air. This tended to cause rapid deterioration of the steel tuyeres formerly used, so that the cast-iron construction should add to the longevity of the new stoker.

Both the upper and the lower runs of grate travel on skids and pass over idler drums on the rear shaft, the latter being free to rotate as well as the drums, thus giving double protection against the danger of binding. The stoker links also are of a new size, having been reduced from 1½ to ¾ in. in width. They are slotted on one side and across the top of the link so that the entire top surface is active burning area. Along the sides of each link are vertical baffles to prevent air from traveling along the chains. Additional baffles are placed under the ends of adjacent links in the same strand to prevent drippings from falling through at this point. At the sides of the links there is little opportunity for drippage, as a flat plain surface on one link presses against the slotted surface of an adjacent link and the slots are small and closely spaced to divide the air distribution finely. At either side of the stoker adjustable underlapping ledge plates and special overlapping side links provide for expansion and contraction of the chains and at the same time prevent air leakage and drippage at these points.

Other features of the stoker are front adjustment of the chain tension, fine adjustment of the gate opening by means of a worm sector and handwheel combination, and a new type of fully inclosed continuous drive. The ratchet has been replaced by a double worm and gear drive, belt-connected to a 3-hp., direct-current motor mounted on the head frame of the stoker, the latter being regulated by a street-car type of controller to give a speed range for the stoker of from 3¾ to 9 in. per min. Between peaks the average stoker speed is about 6 in. per min. The driving and driven pulley each has a face of 6 in. and the diameters are 6 and 42 in. respectively, thus giving a reduction between the motor and the gears of 7 to 1. Thrust plates take up the thrust of the primary and secondary worm shafts.

Air is supplied to each stoker by its individual fan rated to supply 60,000 cu.ft. of air per minute against a static pressure of 2½ in. The driving is done by a variable-speed alternating-current motor rated at 25 hp. and under the control of a regulator manipulated by a small direct-current motor that in turn is regulated by a street-car type controller on the boiler-room floor. Ducts from the fans lead to the stoker windboxes, on each side of each stoker, admission to the air chamber of each zone being effected through hand-controlled dampers whose positions determine the volume and pressure of the air for each zone. Cross-connections between the inner ducts make it possible for either fan to supply both stokers of the unit or to equalize the pressure between the two. With each fan running as they do normally, capacities up to 300 per cent of boiler rating are guaranteed, while one fan has sufficient capacity to supply both stokers and carry the usual load between peaks, which ranges in the vicinity of 200 per cent of rating.

Practical Suggestions on Key Fitting

By T. W. Airey

In keying up parts of machinery, one should take into consideration the section or strength of metal at the crown of the keyway. One must also decide whether in the particular case the key should be a tight fit on the sides of the keyway with an easy fit on the crown, or whether the fit should be on the crown and the sides also, or whether the side fit should be a secondary consideration.

As example, suppose it is necessary to key a pulley on an engine shaft. As the pulley is to be used for the purpose of transmitting power to some other part of the machinery, the fit of the key should be on the crown. If there is ample room on the crankshaft, the best form of key to use for the purpose of keying up the pulley is the gib-headed key shown in Fig. 1 *B*. Smooth out the keyseat in the shaft and make the key a good sliding fit. Now try it in the pulley and if too tight do not ease the key, but ease out the keyway in the pulley until the desired fit is obtained. With the pulley on the shaft drive the key lightly to a gentle bearing. Do not force it with heavier blows, for should it be bearing harder near the head, you may find that you are working the key into wedge form, consequently a heavy blow with the hammer might wedge open and split the pulley, as shown at *d*, Fig. 1 *A*. When the key is withdrawn, the marking will indicate the fit, and if the key is measured at *e*, Fig. 1 *B* and compared with *f* it will be seen whether you are keeping the cor-

rect taper. By using a straight-edge along the key, it is possible to check the evenness of the surface.

In keying up a flywheel or heavy pulley, we may proceed in a similar manner, but can use heavier blows in finally driving home the key because in the flywheel hub there is ample strength to resist the extra pressure set up by the driving. There is one important point that is essential to the successful keying—the base of the hub must be a good fit to the shaft and the machining a smooth finish, otherwise the keyed piece may be thrown out of true during the process of keying up. When the key is driven home, it should force the hub out in the direction of *G*, Fig. 1 *A*, causing the hub to grip the shaft; this contributes to an efficient drive.

With the wheel in position on the shaft, make a careful examination of the keyways, noting particularly if the keyways in the shaft and wheel coincide. If they do not, then alterations must be made until they do line up. Do not try to key up the wheel if the keyways are on the cross. The result may be disastrous.

Make the key a good sliding fit in the keyway of the shaft and also in the hub of the wheel. Smear over

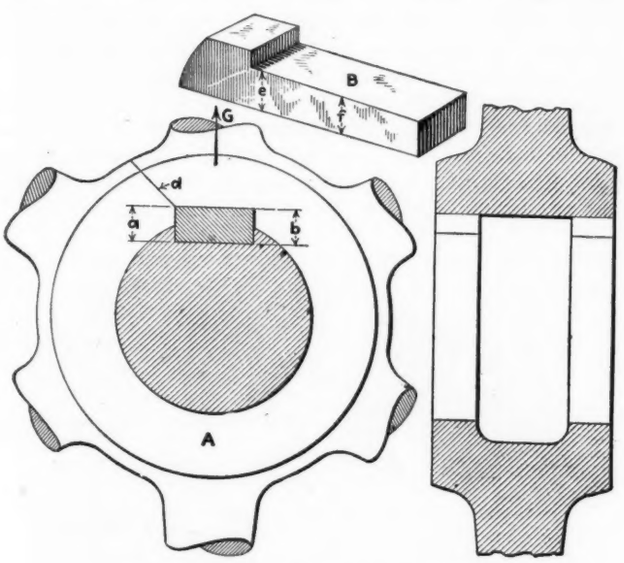


FIG. 1—KEYING A DRIVING PULLEY

the keyways with red lead and try the key for fit, driving it to a gentle bearing. Next take the key out and ease it according to the indications of the marking, and again try the key. Extract the key, try it carefully with the calipers and straight-edge to see that you are keeping the correct taper. If the key seats top and bottom and across its full length and has entered the keyway a sufficient distance, it must be filed slightly to allow for the final drive.

The greatest care must be exercised in checking over the key, for should it be worked out of the correct taper into wedge form, the wheel may be thrown out of true when finally driving home the key. An example of this is shown in Fig. 2, which represents a wheel hub *A* assumed to be a good fit to the shaft *S* while the key *K*, which has been worked out of the correct taper (or fits tighter near the head), on being driven tightly home fits only at *b*. The wheel will spring over so that instead of the plane of its diameter standing at right angle to the axial line of the shaft as at *C*, it will stand at an angle at *d*, throwing wheel out of true.

If the strain of the key or keys is to be depended upon to secure the wheel firmly to the shaft, they must fit top and bottom, and their accurate fit becomes of the first importance because not only is it necessary that they fit equally at each end, but they also fit equally across the width of the key at each end. If the key is binding most at the corners, as shown by the dotted surface *c* and *d*, Fig. 3, the result will be that the key pressure would have a tendency to twist the wheel.

Supposing the keyway in the shaft and wheel are not coincident but are on the cross, the keyway in the

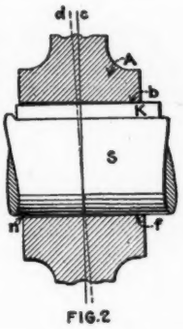


FIG. 2

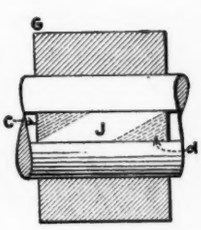


FIG. 3

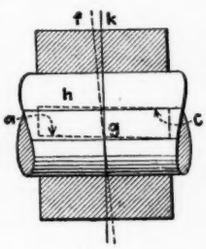
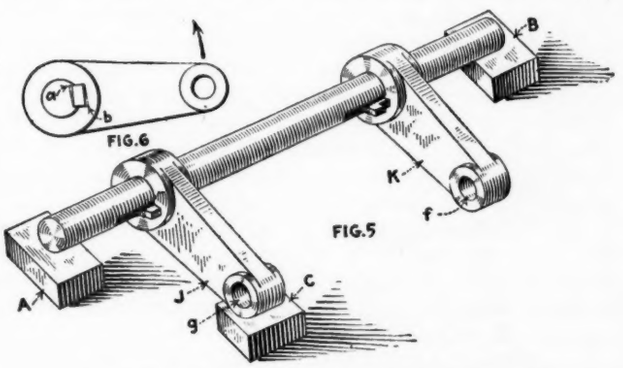


FIG. 4

FIGS. 2 TO 4—FITTING KEYS

shaft being parallel to its axial line, while that in the wheel is on the cross or in the position represented by the dotted lines *g* and *h*, shown in Fig. 4 (much exaggerated for the purpose of illustration), then the key will bear on the side at *a* and *C*. The key pressure would have a tendency to twist the wheel out of truth in the direction of the line *f*.

For keying up heavy gears, it is usual to employ two or more keys. When two are used, they are generally put in at right angles. Assuming that the keyways in the shaft and hub are coincident, try the key for fit. In this case the key must be a tight fit on the sides with a driving fit on the crown. Follow the instructions given for the keying up of the flywheel. It will be appreciated why special attention and care should be devoted to the keying up of gears and how

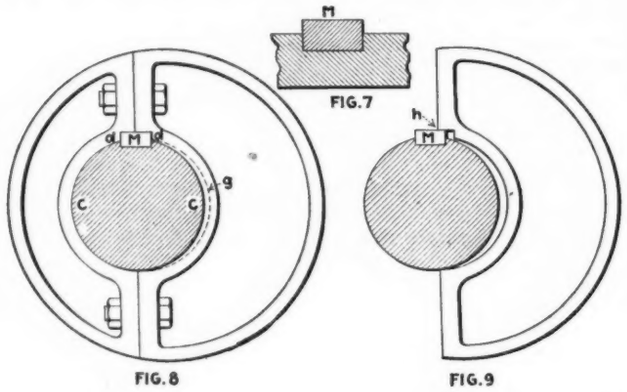


FIGS. 5 AND 6—KEYING LEVERS TO SHAFT

essential it is that the keys should have a good side fit in both hub and key bed in the shaft, and that when two or more keys are employed, the keyways in both hub and shaft must be coincident. Especially does this apply to keying up heavy gears which are subject to severe shocks and strains often in reverse directions.

In our example, Fig. 5, we will assume that two levers, *J* and *K*, are to be keyed up in perfect alignment, therefore the greatest care must be exercised in the process. Do not fit in and finish off one key at a

time, as you may find that with the second keying up the two levers cannot be brought into alignment. The better plan is to fit in both keys a little distance and then try over the levers for alignment. We will assume that both keys have been let in a little distance; take the shaft and lay it on two V-blocks or parallel strips, as *A* and *B*, the end of one lever resting on the packing piece *C*, as shown. With the scribing block set to the edge of the pin-hole *g* in lever *J* (assuming that the



FIGS. 7 TO 9—FASTENING ECCENTRIC ON CRANKSHAFT

pinholes in both levers are of the same diameter), try the setting to the edge of the pinhole in lever *K* at *f*. If the two are at the same height, keying up may be proceeded with, trying over the levers each time the key is driven home. But supposing the levers are not in alignment on the shaft, the necessary alteration must be made to bring them true. It is better to make the alterations to both levers if the malalignment is excessive, but if the inaccuracy is only small the alteration to one lever will suffice. Assuming that the lever requires throwing over in the direction indicated by the arrow in Fig. 6, with a flat scraper take a little out of the key bed in the direction shown by the dotted line *a* and with a smooth file or scraper take a little out of the crown of the keyway in the lever in the direction shown by the dotted line *b*. Try the key in again and test with the scribing block for alignment.

It is not always practicable or even possible to use the gib-headed or driving key. Take, for example, the keying up of an eccentric that is put together in halves. Obviously, the driving home of the key with sufficient force to hold the eccentric secure on the crankshaft would bulge or break the eccentric. Sometimes there is not sufficient room to allow for the use of the driving key, therefore we make use of the sunk key as shown at *M*, Fig. 7. Assuming that we are about to key up a set of eccentrics on the crankshaft, which are put together in halves, using the key as shown at *M*, great care must be taken or the eccentric may be sprung out of round, for once the eccentric is sprung by keying up, withdrawal of the key does not necessarily reduce the spring of the eccentric.

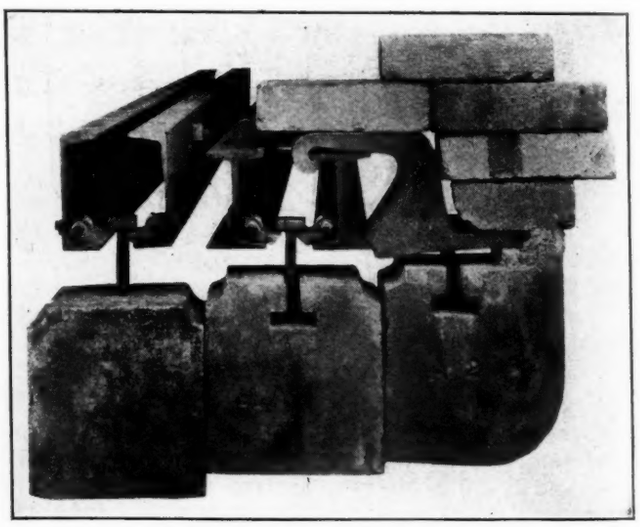
Put the eccentric together and bolt up. Try the key in the eccentric for side fit. This must be a tight fit, for upon the side fit depends the success of the operation and not upon the crown fit, which in this case is of secondary importance. Next try the key in its seat in the shaft. Here the key must be a driving fit. Having finished the key satisfactorily, drive it home in the shaft until the blows give off a ring of solidity at all points along the key. With a calking tool go lightly around the key and afterward file off all burrs and sharp edges from the shaft and key. Disconnect the eccentric and try one-half of the crankshaft as shown at *h*, Fig. 9, and ease the crown of the key *M* with the file until the keyway in the eccentric is just filled without any pressure on the crown and until the eccentric bore bears on the crankshaft.

If the eccentric were to be forced by pressure on the key, the result would be a springing or bulging out at *g*, Fig. 8. Proceed in like manner with the other half of the eccentric. Put the two halves together on the shaft and draw up on the bolts, noting whether the eccentric is coming together without binding.

Tile May Be Individually Replaced in "National" Arch

In the furnace arch illustrated, each tile hangs on a separate cast-iron bolt whose head rests on a pair of hinged clips, between two channels. A feature of the arch is the ease and speed with which a burned tile may be removed and replaced.

To replace a tile, the slag is first broken by chipping around the tile with a chisel. The old tile is then broken out, and the bolt is removed through the opening, inserted in the slot of a new tile and then replaced by pushing the new tile up into place. As this is done, the bolt head pushes up the hinged clips until it has passed them, when the clips drop back into the horizontal position. The tile is then lowered until the bolt



"NATIONAL" FURNACE ARCH

head rests on the clips. Pointing around the edge of the new tile with fireclay or high-temperature cement completes the repair, which, it is said, may be made in fifteen minutes.

The row of end, or "nose," tile and the adjacent row are hung on a pair of heavy I-beams. Each end tile is hung from a special bracket, hooked over the last I-beam, as shown. The bracket supports, in addition to the end tile, the two or three courses of brick between the top of the nose tile and the top of the I-beams.

A free circulation of air around the ironwork is obtained. By the use of long or short bolts, the arch may be adapted to high or low settings. It is made by the M. A. Hofft Co., Lemcke Building, Indianapolis, Ind.

Causes of Reversed Polarity in Direct Current Generators

A Number of Conditions That May Cause Reversal of Polarity on Direct-Current Generation Are Discussed—How To Correct Reversed Polarity

BY CLARENCE LYNN
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THERE have been a considerable number of reports of cases of reversal of polarity of direct-current generators under many and varied conditions, some of which could be accounted for and others could not. In many cases of reported reversal of polarity the reversal of the generator could not be made to occur under the conditions reported when the case was investigated, nor could a reversal be accounted for.

SHUNT NON-INTERPOLE GENERATOR

Consider the shunt-wound non-interpole generator. As this machine is seldom used without the brushes shifted forward for improving commutation, it will be considered only in this connection. A short-circuit on this generator operating alone can cause a reversal of polarity, for when the short occurs there will be a heavy demagnetization of the field due to the shifted positions of the brushes. This can be easily seen by referring to Fig. 1. Let the brushes, instead of being placed midway between the main poles, be placed off neutral so that the north pole of the armature is moved toward the north main pole of the machine. Then the

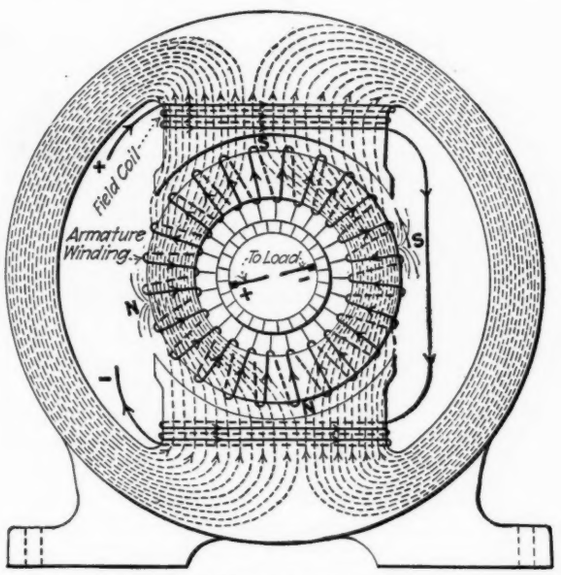


FIG. 1—ARMATURE POLES TEND TO DEMAGNETIZE MAIN POLES

armature field flux will oppose or partly oppose the main field flux, and demagnetization of the main fields will occur. If the shift be sufficient and the short-circuit current heavy enough, the opposing armature field may even buck down and reverse the direction of the residual magnetism of the generator, and when the machine is started up again its polarity will be reversed, since the residual magnetism is in the opposite direction. In this case the only way to change the polarity back to the initial conditions is to reverse the residual magnetism by sending an external source of current through the shunt field or by letting the machine build up with the wrong polarity and short-circuiting it again, thus bringing back the original

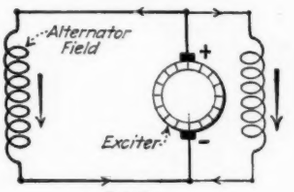


FIG. 2

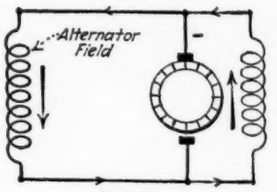


FIG. 3

FIGS. 2 AND 3—SHOW HOW EXCITER'S POLARITY MAY BE REVERSED BY OPENING ARMATURE'S CIRCUIT

conditions. The latter method is not recommended, however.

If the generator were working in parallel with other machines or charging a storage battery, and its voltage were to drop owing to a reduction of the field current or speed, the current in the armature would become reversed, the shunt-field current would remain in the same direction, and the machine would now operate as a shunt motor running in the same direction as it did when it was operating as a generator, and there would be no reversal of polarity, the only bad effect being that of vicious sparking due to the shifting of the brushes in the wrong direction for motor operation.

SHUNT-WOUND INTERPOLE GENERATOR

Now consider the shunt-wound interpole generator. If this generator be working by itself and becomes short-circuited, a large current will flow in the armature, thus producing a large armature field, and at the same time the main field will be reduced owing to armature distortion and lower terminal voltage. Unless the machine flashes over, there is slight possibility of the armature demagnetization being strong enough to oppose and buck down the main field and reverse the polarity of the residual magnetism and thus the polarity of the generator. If this machine be working in parallel with others or by charging a storage battery and its voltage be reduced, it likewise will operate as a shunt motor, running in the same direction as when it was driven as a shunt generator. Since the interpole fields are connected directly in series with the armature, when the current in the armature reverses, the polarity of the interpoles automatically reverses, thus making them the right polarity for motor operation, and no sparking occurs as in the non-interpole generator.

Consider further the shunt generator supplying excitation to an alternating-current generator and that for some reason the voltage of the exciter drops, due to an opening of the shunt-field circuit or the insertion of a relatively large part of its rheostat resistance in the circuit. Then there is a possibility of the alternator fields inductively maintaining a current flow through the armature of the exciter for a short period, in which case the polarity of the field poles may be reversed owing to armature distortion, particularly if the brushes are shifted slightly ahead of the neutral. The same effect occurs in the interpole generator with the brushes shifted off neutral with the addition of the interpole winding acting as a series winding to some extent, with either a cumulative or differential effect, depending upon whether the brushes are shifted backward or forward from neutral. In the latter case there is the possibility of the machine's reversing its polarity if a heavy enough current flows in the armature. If the brushes were shifted back of the neutral, then with either the non-interpole or interpole machine there would be small possibilities that the polarity would be reversed, since the armature poles tend to maintain the polarity of the main poles.

Alternator's Field Winding May Reverse Polarity of Exciter

If the armature circuit of an exciter were to become open-circuited, the inductive current set up by the alternator field winding would reverse the polarity of the exciter field winding. In Fig. 2 the circuits through the exciter and alternator field windings are shown in their normal relation. Now if one of the brushes were to be lifted from the commutator, such as might be the case in a two-pole machine with two brushes, the armature circuit would be opened. The flux dying down in the alternator's field poles would cause a voltage to be induced to maintain the current flowing in the circuit. This current would flow through the field winding of the exciter in a reversed direction, as can

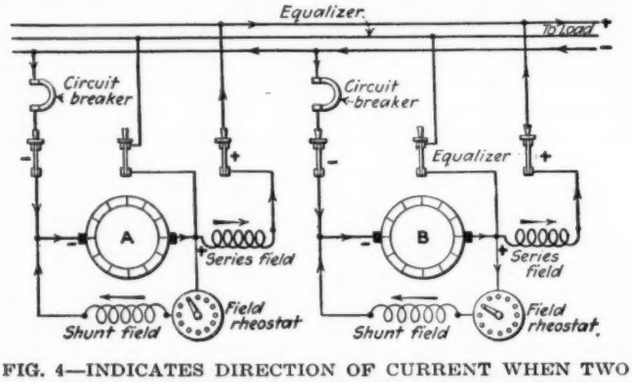


FIG. 4—INDICATES DIRECTION OF CURRENT WHEN TWO COMPOUND GENERATORS ARE OPERATING PARALLEL

be seen by comparing Figs. 2 and 3, which would cause a reversed polarity of the field poles

The conditions for the compound-wound machine differ from those of the shunt-wound machine in that the effect of the series winding is either to oppose the effect produced by the shunt field or add to it, depending on how the machine is connected and how it is operating. Thus in the case of a heavy overload on a generator, where the series and shunt windings have the same polarity, the series winding opposes the demagnetization of the main fields caused by the armature reaction and tends to reduce the possibility of polarity reversal. In the case of a reversed current in the armature the current in the series windings produces a field that opposes the main field and thus improves the chance of reversal. If the machine be differentially wound, the effects produced by the series winding will be just the opposite to that mentioned in the foregoing.

If two compound generators are operating in parallel, as in Fig. 4, and for any reason one machine motorizes

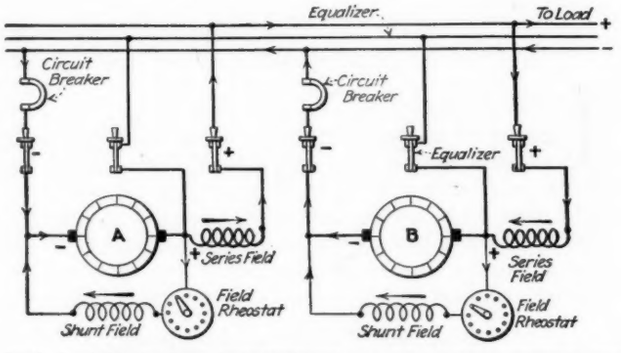


FIG. 5—INDICATES DIRECTION OF CURRENT WHEN ONE COMPOUND GENERATOR MOTORIZES ANOTHER

the other—for example, machine *A* motorizes *B*, as in Fig. 5—the current in the series winding will be reversed and tend to reverse the polarity of the main poles. This will be made clear by comparing the direction of the current in machine *B*, Figs. 4 and 5. Whenever a cumulatively connected compound-wound generator is motorized, it takes such a heavy current that the circuit breaker is opened, but before this happens the current has reached a value in the series winding to make it stronger than the shunt and reverses the polarity of the main poles. For the same reason if a dead compound generator were connected to a live busbar, its polarity would be reversed. Where a compound generator is used to charge a storage battery, it should be protected by a reverse-current relay, since if its voltage is reduced below that of the battery, a reverse current will flow through the armature. Unless the machine is disconnected before this current reaches a large value, the polarity will be reversed due to the series field opposing the shunt.

Load on Generator Caused Reversed Polarity When Machine Slowed Down

There are cases on record where the load on the generator has set up a reverse current through the armature and series winding and reversed the polarity of the machine. Where a compound generator is supplying power to motors driving a load having a large inertia—that is, having a heavy flywheel effect—if for any reason the voltage was to drop suddenly on the generator, the load would drive the motors as generators and supply current back through the armature and series winding of the generator in the reverse direction. This current might reach proportions that would reverse the polarity of the generator, as experience has shown. This could be caused by a sudden cutting off of the steam from the engine or an opening of the shunt-field circuit. A case in mind is where the governor rod on a Corliss engine unhooked and allowed the engine to slow down. Before the engine had time to come to rest, the engineer hooked the rod up again and went to the switchboard, where he discovered that the voltmeter needle was thrown backward off the scale, thus indicat-

ing that the polarity of the generator had been reversed when the engine slowed down.

When the polarity of a generator has been reversed, the difficulty can be corrected by sending a current through the shunt winding in the proper direction. If it is not known which is the right direction, try one

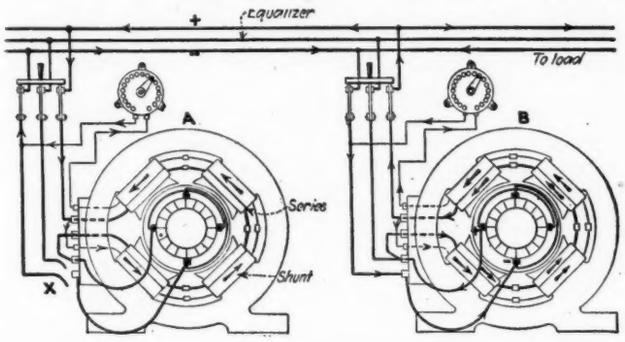


FIG. 6—HOW TO MAGNETIZE THE SHUNT FIELD OF A COMPOUND GENERATOR FROM BUSBARS

way and if this does not give the correct polarity when the machine is started, then try sending current through the field windings in the opposite direction.

Where the generators are operating in parallel and the polarity of one of the machines becomes reversed, this can be corrected as indicated in Fig. 6. The armature circuit is opened on the machine with the reversed polarity, as in the figure at *X*, on machine *A*, and the switch closed to the bus. This excites the field coils in the correct direction. After the field coils have been connected in this way for about one-quarter minute or more, the switch is opened, armature connected up and the machine started. If this has been done properly, it will be found that the machine will build up the right polarity. Care must be exercised in opening the armature circuit to be sure that it is open, otherwise there is danger of seriously injuring the machine should its armature be connected to the live bus.

If the armature and equalizer connection are opened as in the figure, then there can be no mistake made that will connect the armature directly to the bus. Should the lead between the series field and the busbars be opened instead of the armature, if the equalizer is disconnected also, then when the switch is closed to the bus, nothing will happen; whereas, if the equalizer were not disconnected, the armature of the machine would have full voltage applied, which would not only open the circuit breakers, but would be liable to damage the machine. Dead machines have been connected to live busbars by mistake and the resulting damage proved very costly, not considering the time that the machine was out of service to have the commutator or armature windings and core repaired. A few minutes spent on precautionary measures frequently reveal circumstances that would have resulted in costly damage if they had not been discovered beforehand.

Principles and Practical Operations of Absorption Machines

By HEYWOOD COCKRAN*

THE absorption machine is old anyway, Carre's apparatus being one of the earliest forms of refrigeration. This was merely a two-shell affair, one acting alternately as generator and absorber and the other as condenser and cooler. There was no moving part. From time to time the small intermittent absorption machine has bobbed up in some locality, operated by a gas jet, exploited as something new and stock sold.

This early Carre machine does not bear much resemblance to the present-day absorption machine shown in the illustration.

The operation of any absorption refrigerating machine is based on the fact that pure water readily absorbs and holds in solution ammonia gas. The quantity of ammonia it will absorb and hold depends only on the efficiency of the mixing device, the pressure of the gas and the temperature of the solution of aqua ammonia.

A strong solution of aqua ammonia is pumped through the exchanger into the generator. Steam coils heat the solution and drive out the ammonia gas, which is passed through the rectifier or moisture separator, into the condenser. This operation is similar to the discharge stroke of the compression machine and accomplishes the same result, and the same number of pounds of high-pressure ammonia gas must be discharged into the condenser, cooled and liquefied per hour per ton of refrigerating effect. It is then conducted through the feed valve to the expansion coils, where it is allowed to evaporate, as in the compression system, gathering heat from the objects to be refrigerated. Since strong aqua liquor is being continually pumped into the generator and the gas driven off to the condenser, a continuous supply of weak liquor results, which passes out of the generator, through the exchanger, weak-liquor cooler and regulating valve to the absorber for a fresh charge of ammonia gas. The weak liquor enters the absorber through an injector device, drawing gas from the cooler and absorbing it; this process compares with the suction stroke of a compressor. The resultant strong aqua ammonia is taken from the absorber by the aqua pump and forced through the exchanger heater to the generator. The steam coils heat the liquor, distilling off the gas, and the process is repeated continually.

To make its action easy to understand, one may compare the absorption machine with a boiler plant. The aqua pump is the boiler-feed pump; the generator is the boiler, but using steam as its heating medium instead of flue gases; the exchanger is the feed-water heater, although it serves the double purpose of heating the strong aqua entering the generator and cooling the weak aqua from it; the rectifier is the moisture separator, etc.

At atmospheric pressure one part of water at 50 deg. F. will absorb 900 parts of ammonia gas by volume; at 100 deg., only 460 parts. Naturally, the cooler the

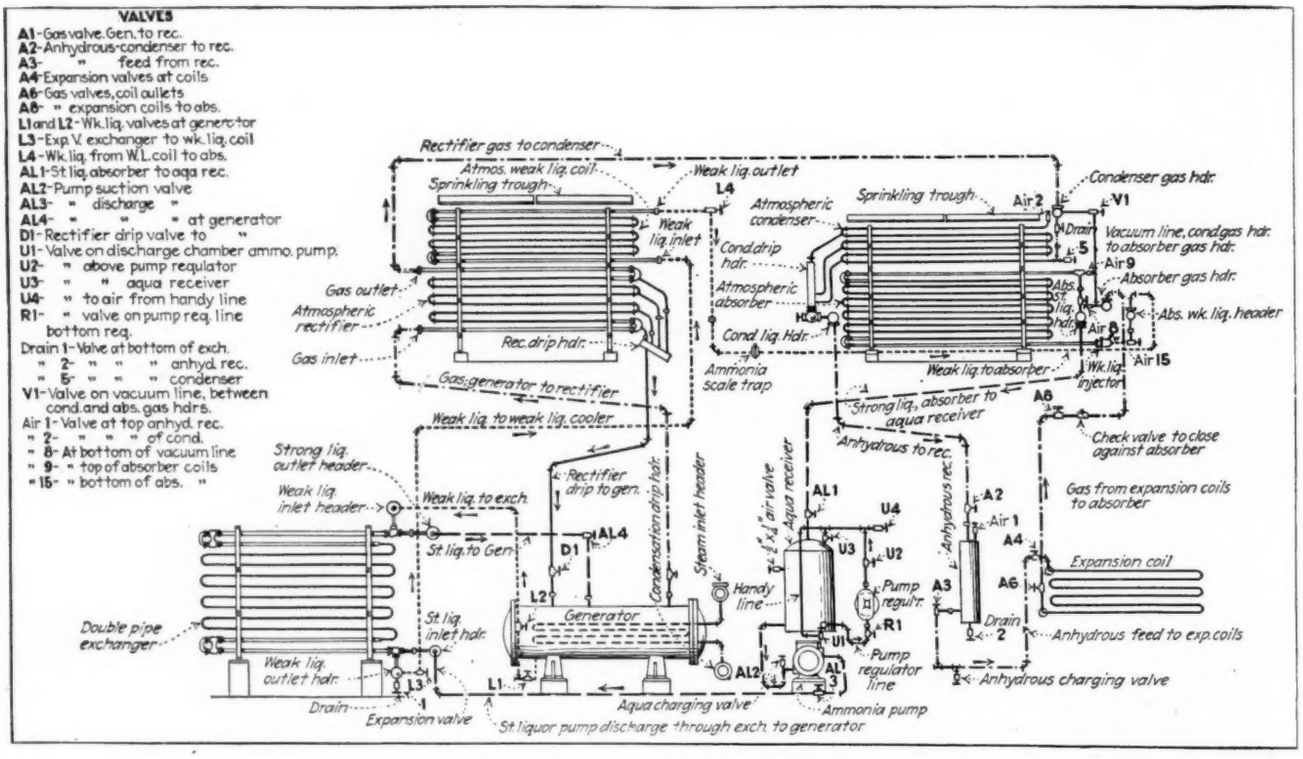
*Engineer with Carbondale Machine Co.

water the more work the machine will do per square foot of surface. It is for this reason that many feel that an absorption machine is all right if there is plenty of cold well water, but no good if the condensing water is warm. It can be shown that the steam consumption of an absorbing machine per ton of refrigeration increases with higher condenser pressures, less than does that of a compression machine. When properly designed, the absorption system is the "warm water" machine.

Except for corrosive water or water depositing an excessive amount of scale, even at low temperatures I would not consider any other than the atmospheric absorption type, for, while indispensable if warm water

In an exhaust-steam machine it is highly desirable to have as low a condensing pressure as possible. The condensers are then placed over the absorbers, all water first running over the condensers. The absorbers are made large enough to give their capacity with the warm water coming off the condenser. This reduces the condensing pressure to a minimum. Since the lower the condensing pressure the lower the exhaust steam pressure in the generator coils need be, this arrangement is of advantage.

The rectifier is placed under the weak-liquor cooler. The gas from the generator goes there first, and any water vapor carried over is condensed. In the modern absorption machine it is entirely possible to have liquid


VALVES
A1-Gas valve, Gen. to rec.
A2-Anhydrous-condenser to rec.
A3- " feed from rec.
A4-Expansion valves at coils
A5-Gas valves, coil outlets
A6- " expansion coils to abs.
L1 and L2-Wk. liq. valves at generator
L3-Exp. V. exchanger to wk. liq. coil
L4-Wk. liq. from W.L. coil to abs.
AL1-St. liq. absorber to aqua rec.
AL2-Pump suction valve
AL3- " discharge "
AL4- " " " at generator
D1-Rectifier drip valve to "
U1-Valve on discharge chamber ammo. pump.
U2- " above pump regulator
U3- " " aqua receiver
U4- " to air from handy line
R1- " valve on pump reg. line
bottom reg.
Drain 1-Valve at bottom of exch.
" 2- " " " anhyd. rec.
" 5- " " " condenser
V1-Valve on vacuum line, between cond. and abs. gas hdrs.
Air 1-Valve at top anhyd. rec.
" 2- " " " of cond.
" 8-At bottom of vacuum line
" 9- " top of absorber coils
" 15- " bottom of abs. "
Rectifier gas to condenser
Atmos. weak liq. coil
Sprinkling trough
Weak liq. outlet
Weak liq. inlet
Gas outlet
Atmospheric rectifier
Rec. drip hdr.
Gas inlet
Gas generator to rectifier
Weak liq. to weak liq. cooler
Strong liq. outlet header
Weak liq. inlet header
Weak liq. to exch.
St. liq. to Gen.
Rectifier drip to gen.
Condensation drip hdr.
Steam inlet header
Double pipe exchanger
St. liq. inlet hdr.
Generator
Weak liq. outlet hdr.
Drain
Expansion valve
Aqua charging valve
St. liquor pump discharge through exch. to generator
Ammonia pump
Handy line
Pump regul'r.
Pump regulator line
Aqua receiver
Anhydrous rec.
Anhydrous to rec.
Atmospheric condenser
Cond. drip hdr.
Atmospheric absorber
Cond. liq. Hdr.
Ammonia scale trap
Weak liq. to absorber
Strong liq., absorber to aqua receiver
Condenser gas hdr.
Vacuum line, cond. gas hdr. to absorber gas hdr.
Absorber gas hdr.
Abs. wk. liq. header
Wk. liq. injector
Check valve to close against absorber
Gas from expansion coils to absorber
Expansion coil
Anhydrous feed to exp. coils
Anhydrous charging valve

DIAGRAMMATIC OUTLINE OF AN ABSORPTION MACHINE

only is procurable, it is equally good for cold water. There is a cooling effect, due to evaporation that cannot be obtained in a closed-type machine. Usually, the absorber in a tubular machine is in a single unit, and if an absorber tube leaks or the absorber has to be cleaned, the whole plant must be shut down. In one large plant having tubular absorbers, each machine was shut down one hour of the twenty-four, to test the outlet cooling water with litmus paper for leaks.

In an atmospheric absorption machine each stand of the absorber is made of 2-in. pipe, 12 pipes high and 20 ft. long, and is good for about six tons' refrigerating effect. An absorber of 16 stands is usually called a 100-ton refrigerating machine, and 24 stands 150-ton, etc.

The condenser is placed immediately over the absorber. As counter-current atmospheric condensers, 12 pipes high, are good for at least 12 tons' refrigerating effect, the work to be done is balanced by cutting the condenser in two, making six pipes over each absorber stand, so the combined stand, 18 pipes high, is then good for about six tons of refrigerating effect.

anhydrous live up to its name and be bone dry. In olden days there was frequently anywhere from 10 per cent to 30 per cent moisture carried over into the tank coils, requiring frequent purging and making a flooded system impossible.

Preferably, the water-cooled rectifiers should be cooled by cold strong aqua, for better regulation can be obtained. When the strong aqua is so heated, the weak aqua is not properly cooled in the exchanger, and more weak-liquor surface must be used. The advantages of maintaining such conditions greatly outweigh this disadvantage.

Particular attention is called to the mixer in the absorber in the illustration. The weak aqua leaves the generator at a pressure of 120 lb. to 200 lb. It passes through an injector nozzle beyond the gas inlet at the absorber and draws in the gas. In other words, the attraction between the gas and the weak aqua ammonia is not depended upon to do all the mixing.

Gardner T. Voorhees, in a paper read some years ago before the First International Congress of Refrigeration, in Paris, which appeared in his book "Compres-

sion-Absorption Machines," published in London, gave the heat balance of an absorption machine as follows:

HEAT ADDED PER MINUTE

Generator	496 B.t.u.
Cooler	200 B.t.u.
Total	696 B.t.u.

HEAT REMOVED PER MINUTE

Absorber	393 B.t.u.
Condenser	220 B.t.u.
Rectifier	93 B.t.u.
Total	696 B.t.u.

It will be seen from this that comparing the actual number of B.t.u.'s used to do the work, the absorption system seems quite wasteful compared to the engine of a compression machine, but actually this engine uses only a small percentage of the heat of the steam entering it. The remainder passes out in the exhaust. In the absorption system the steam is actually condensed and practically all of the latent heat used.

In this connection the question of tracing where the heat in one pound of coal goes is of interest. Take a pound of coal of 13,500 B.t.u.; the compressor engine uses 1,273 B.t.u. and wastes 7,737 in the exhaust, as shown in Table I. It is because the absorption system can use these 7,737 B.t.u. contained in the exhaust that it can procure more refrigeration with the exhaust from the compression machine than the compression machine can produce with the live steam it uses.

TABLE I—WHAT BECOMES OF HEAT IN ONE POUND OF COAL IN A COMPRESSION PLANT

Lost in ashes	135	
Lost in radiation from boiler	675	
Carried off in gases	2,970	
Carried off in auxiliary exhaust	190	
		3,970
Lost in radition and leakage, main pipes	210	
Lost in radiation and leakage, small pipes	30	
Lost in radiation and leakage, engine pipes	280	520
Rejected to condenser exhaust steam	7,737	7,737
Total Loss	12,227	12,227
Converted to power used by compressor	1,273	1,237
	13,500	13,500

To go back to the heat balance, 496 B.t.u. per minute per ton was added in the generator. This is based on 170 lb. condensing pressure and 15 lb. absorber pressure. Multiplying 496 by 60 and dividing by the B.t.u. in a pound of steam, we find that a generator uses 32.8 lb. of steam by weight per ton of refrigeration per hour. Mr. Voorhees shows this in a table, this being Table II.

TABLE II—POUNDS OF STEAM PER MINUTE PER TON OF REFRIGERATION

Suction Pressures, Gage	Machine*	Condenser Pressures, Gage 140	170	200
0	S.C.	78.3	90.5	104.0
	C.C.	42.0	48.4	55.6
	A.	31.8	43.4	51.1
15	S.C.	44.5	52.5	61.4
	A.	29.5	32.8	36.4
	C.C.	23.8	28.0	32.7
30	S.C.	31.1	37.2	44.5
	A.	24.3	28.0	30.1
	C.C.	16.6	19.0	23.9

*S.C. stands for simple Corliss. C.C. for compound Corliss, and A. for absorption machine.

On this basis with 0 lb. gage suction the absorption machine beats both the simple and compound Corliss machines at all stages. It beats the simple Corliss at all the pressures given, but is less economical than the compound Corliss at the higher suction pressures. However, this does not take into account the auxiliaries, and when one remembers that this adds little to the steam consumption of an absorption machine, as the exhaust can be used in the generator, but adds materially to the steam consumption of the compression system, the exhaust-steam absorption machine will make a materially better showing than the values given in Table II.

The table also shows why the absorption machine properly designed is the real warm-water machine. At 15 lb. suction pressure and the 140 lb. condensing pressure, its steam consumption is 29½ lb. of steam, while at 200 lb. pressure, it has increased only to 36.4 lb., or 6.9 lb., less than 25 per cent. The steam consumption of the simple Corliss compressor under the same conditions will increase from 44½ lb. to 64.4 lb., or 40 per cent.

In operating the absorption system the water supply should be as regular in flow as possible. As a general rule the quantities shown in Table III should be used per ton of refrigerating capacity of the machine.

TABLE III—CONDENSING WATER

Water Temperature, Deg. F.	Gal. per Min. per Ton
50	2
60	2.5
70	3.25
80	4.25
90	6.

Using the amount of water shown in Table III the generator pressure and the temperature of the gas leaving the rectifier should approximate the values in Table IV.

TABLE IV—ABSORPTION SYSTEM TEMPERATURES

Water Temperature Deg. F.	Generator Pressure, Lb. Gage	Gas Temperature Leaving Rectifier, Deg. F.
50	105	86–96
60	125	95–105
70	145	102–112
80	166	109–119
90	192	118–128

Regarding the amount of aqua to be pumped, this is between 0.5 and 0.6 gal. per ton of refrigeration per minute.

Aqua Strength Important

Some builders tell operators to forget the strength of the aquas. If the machine is clean and tight and of a size to do the work with certain steam pressures, the level in the receiver gage glass is the thing to watch. If this level goes down when expanding the proper amounts of liquid anhydrous, enough liquid anhydrous should be added to the system until the level can be maintained with the steam pressure specified.

Regarding the strength of the ammonia charge, engineers frequently say, "It is the end of the season and our charge is weak, but we won't strengthen it until spring." They do not seem to realize that if the aqua was so weak that it had no ammonia in it, it would condense just as much steam in the generator coils but would make no ice. The cost of the extra ammonia to keep the system properly charged is much less than the cost of coal wasted.

The same general rules apply for the proper operation of both absorption and compression plants. Keep the machine tight, clean and well charged. The details of operation, how to open up an absorption machine are always in the instruction book of the machine builder.

Some engineers feel that the absorption system is dying or dead. In fact, more absorption machines are now being made than ever before. Such plants as packing houses, ice-cream factories and compression ice plants desiring to increase capacities can generally use an absorption machine to great advantage. A very large number of exhaust-steam machines are used in oil refineries, because they have plenty of exhaust steam, and low temperatures are desired.

The Opposed-Piston Principle for High-Power Diesel Engines*

SOME few years ago the opposed-piston principle was introduced as a practical method of reducing the weight and floor space of the internal-combustion engine. The soundness of the principle was soon recognized by the engineering profession, matters going so far as to lead to the building of a large British gas engine to this design. The war, however, somewhat interrupted the experimental work, which promised to justify expectations, and only during the last year or so have large units for commercial work been built.

These engines have been exclusively oil engines, the Diesel cycle being adhered to. It is not surprising, in view of the great interest taken by British marine engineers in the Diesel engine, that the first engines of the opposed-piston type have been built for ship propulsion. In fact, the policy of shipbuilders in Great Britain has been to welcome any new design of internal-combustion engine suitable for large powers and to try it out thoroughly.

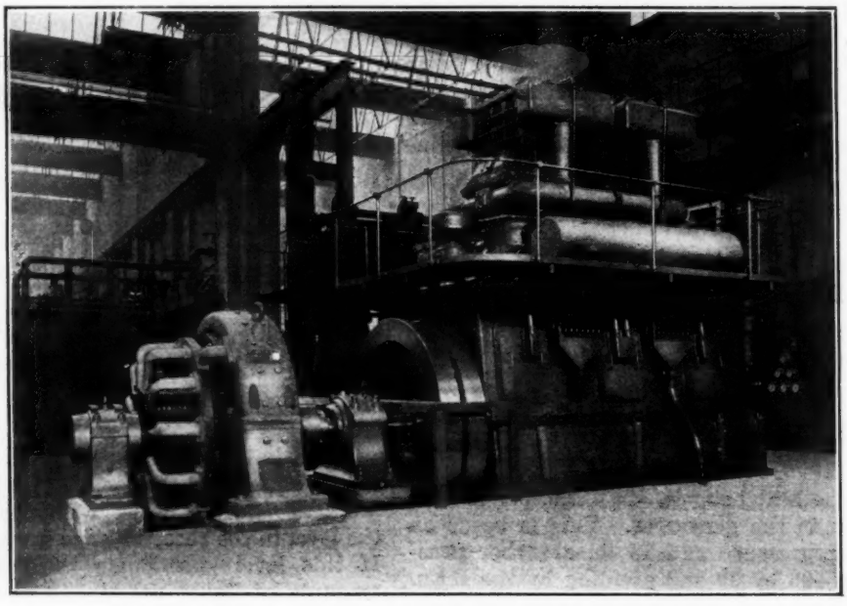


FIG. 1—FULLAGAR DIESEL FOR STATIONARY SERVICE

There are now several distinct types of marine oil engine, some of considerable power, in daily operation under seagoing conditions, and the results obtained from their performance have been of the utmost value in assisting the evolution of a satisfactory design.

It does not seem probable that any particular one is likely to supersede the others. Each builder has reasons for adhering to some special design, and while such designs differ in detail, with the exception of the engine under discussion, they have much in common.

In the very early days of the marine oil engine the two-stroke cycle received attention; this was followed by a period of marked preference for the four-stroke cycle. Recently, the tendency is to revert to the two-stroke cycle for engines of large powers.

While the opposed-piston engine operates on the two-stroke-cycle principle, it represents a distinct type. A general idea of the opposed-piston engine can be gained from a study of Fig. 2 *A*. Here there are two pistons moving in opposite directions in one cylinder. The top piston first uncovers the exhaust ports, which extend all around the cylinder bore, then the lower piston uncovers a set of scavenge ports at the bottom end of the cylinder. These latter ports also extend round the bore, and fresh air at a low pressure, supplied by a pump, enters through them and sweeps out the burnt gases, leaving the cylinder filled with fresh air. This method of scavenging has been used for some years, in both horizontal and vertical engines, by the employment of three cranks per cylinder. In this design the center crank is connected to the piston nearest to it and the two outer cranks are coupled to the piston more remote.

This arrangement is actually adopted in the Doxford marine oil engine, which has four cylinders and in the latest unit develops some 3,000 i.hp. at 77 r.p.m. Solid injection under high pressure is employed in place of the more usual air-blast system, and the actual compression pressure is comparatively low, being but 300 lb. per square inch. This engine gives a higher shaft-horsepower than any other installed in a ship and working on the Diesel cycle, the high mechanical efficiency being ascribed to the absence of the usual air compressor.

There is still another type of opposed-piston engine, known as the Fullagar. The special feature of the Fullagar engine consists in having only one crank and connecting rod per cylinder, Fig. 2 *B*, in place of the three cranks as in Fig. 2 *A*. By connecting the lower piston in the first cylinder to the upper piston in the second cylinder and the lower piston in the second to the upper piston in the first, by pairs of oblique rods external to the cylinders themselves, the need for three cranks per cylinder is overcome.

This offers several advantages. The work that has to be expended in compressing air in the cylinder adjoining that in which combustion is taking place is done directly by means of the external oblique rods instead of being transmitted through the crankshaft as in all other types. The lubrication of the main bearings of the crankshaft and connecting rods is thus rendered easier by the latter being in alternate compression and tension, this reversal allowing the lubricating oil, supplied under pressure, to flow freely over all bearing surfaces. The loads on the main bearings are greatly reduced since the pull of one connecting rod is largely counteracted by the thrust of the adjoining rod.

*This article deals with British practice. The opposed-piston type has long been built in Germany under the Junkers patents and several were built in the United States.

Excellent balance is obtained and the engine is suitable for high speeds, and the turning effort is double that of the ordinary four-stroke-cycle engine. This is all important in those engines intended for direct coupling to electric generators.

The recent development of the Fullagar Diesel engine as a marine motor has somewhat obscured its equally

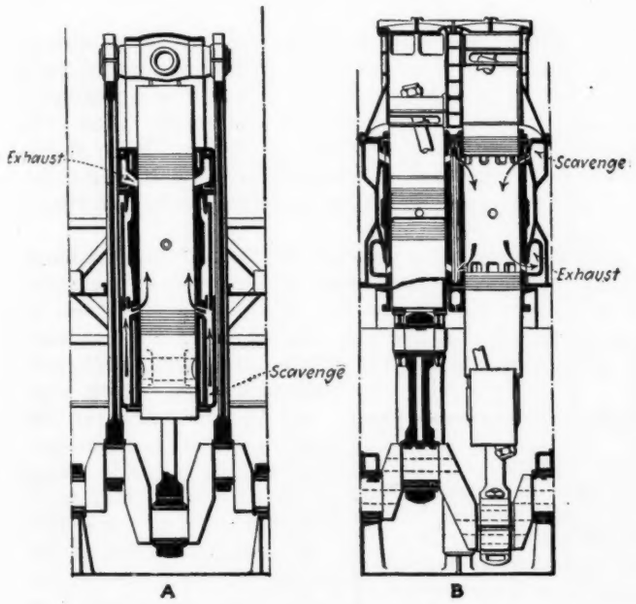


FIG. 2—TYPES OF OPPOSED-PISTON ENGINES

important application in the electrical generating station, although this is now being handled by the English Electric Co.

Demand for Larger Units

The reliable operation of the smaller Diesel engines has brought about a demand for larger units. The development of the Fullagar engine has done a good deal to render this possible. The problem of applying it to this purpose differs, however, from that of the marine engine, inasmuch as, while the slow speed is required on board ship, high speed is necessary for the land engine. While saving of space is not so important on land as at sea, the Fullagar engine effects a considerable saving in this direction, permitting an engine of 1,125 hp. to be accommodated on a floor space very little more than that required for a 500-hp. Diesel of the ordinary pattern. True, extra headroom is necessary to install the engine, but by reason of its construction a rather less working height for the crane is required. Therefore the extra headroom—that is, the space required to withdraw the pistons and connecting rods—becomes negligible.

The engine, as shown in Fig. 1, is coupled to a 500-kw. direct-current generator and is taking the load of the makers' factory. It runs at 250 r.p.m. and with two pairs of cylinders 14-in. diameter by 16-in. stroke, develops 750 brake-horsepower.

The cylinder castings are provided with exhaust and scavenge air belts, which communicate with ports in the liner. The liners are fitted from the top and are provided with the usual means of allowing for downward expansion. Gland rings are fitted to each end of the liner, and a lubricating device is provided whereby oil is delivered through openings at fixed distances around the liner circumference. The oil is introduced between the second and third rings of the piston, and efficient lubrication is thereby obtained.

The upper part of the cylinder castings carry supports for the upper slippers of the diagonal rods. These supports are inclosed and form the scavenge pumps. The scavenging-pump valve boxes are at the side and are so arranged as to act as braces for the upper parts of the engine. The arrangement of the scavenge-air and exhaust systems can be seen from the view of the engine.

An air compressor of the three-stage type is incorporated with the engine. The air for the first stage is taken from the main scavenging pump, a distinct advantage for dusty situations.

No Admission or Exhaust Valves

While there are no admission or exhaust valves on this engine, a horizontal camshaft runs the whole length of the engine. This is for operating the fuel valves, the fuel pumps and mechanical lubricating pumps. The positions of these parts are shown in Fig. 3. The fuel pumps are driven by eccentrics, there being two such pumps. Each pump has two plungers, thus one fuel pump is provided for each cylinder. The usual arrangement for cutting out the fuel is provided, the control lever being situated immediately below the fuel pumps on the crankcase. Starting is by compressed air, the arrangement adopted permitting air to be admitted at the correct time to two of the cylinders. This is effected by a pilot valve which, when the air is turned on at the starting receiver, raises the starting-valve levers to their cams by admitting air pressure to a piston, and at the same time sets the engine in motion.

The governor of the engine is fitted with ball bearings throughout. It is driven off the vertical shaft which

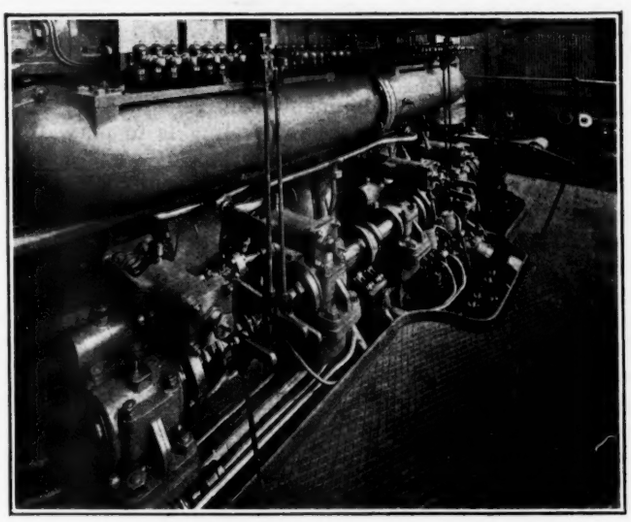


FIG. 3—CAMSHAFT OF FULLAGAR ENGINE

transmits motion by spiral gearing from the mainshaft to the camshaft, a Michell type footstep being provided to take its weight.

This engine follows closely on the lines of the marine type Fullagar engine, all the essential features being retained. The reciprocating parts are in excellent balance, permitting even running at high speed. The average fuel consumption under test was approximately 0.42 lb. per b.hp.-hr. at full load.

Using Shims Instead of Wedges for Leveling Bases of Steam Turbines

By EDGAR C. BARKER, SR.
Turbine Erecting Superintendent, General Electric Company

CAST-IRON bases of turbines or other machines appear strong and rigid. When the machined surfaces, however, are placed accurately in parallel planes by means of careful leveling, the bedplate is found to be comparatively easy to bend or deflect, as indicated by a sensitive level. Permanent "sets" or deflections may be caused by strains in shipment, unloading, contraction from hot to cold, or the operations of wedging and leveling. It is sometimes necessary to remove these permanent deflections, when installing, by special distribution of wedges and pressure of weight or pull of foundation bolts. The bedplates of large or medium-sized machines remind one of the bending qualities of ordinary tin when checked for small deflections with a sensitive level.

WEDGES used for leveling turbines are frequently withdrawn after grouting on account of an occasional tendency to work loose if left in place indefinitely. In addition to this it is sometimes difficult to avoid undesirable deflections when wedging large bedplates. This article outlines an ingenious and practical method of providing a plane surface composed of iron blocks for supporting the bedplate and preventing undue strain while installing, as well as insuring permanent alignment for future operation.

Many harsh words and thoughts are frequently caused when it is found necessary to move one of the bearing pedestals or other dowelled members in order to obtain proper side alignment of a large steam turbine, the base of which has been leveled and set on sixty or seventy sets of good wedges and shims. It is not generally realized that the less localized strain that is placed on a base casting, the better the unit will operate and the longer the alignment will remain true and correct. The usual practice in leveling is to place the base at the proper elevation by means of wedges and shims and then correct the leveling accurately after the proper elevation has been reached. In the case of a bedplate alone, or where the turbine set is of medium size, assembled on the bedplate, or even partly assembled, strains are often produced by driving the wedges unevenly; if wedges at diagonal corners were driven hard enough to lift the whole weight, an excessive deflection would occur in the middle. This would produce a twisting strain in the base which might be severe enough to cause a permanent deflection, which is the most difficult kind to remove and therefore should be avoided if possible. Such a permanent "set" or strain may be eliminated, as far as the leveling is concerned by special distribution of wedges or bolt pressure. When anything occurs to eliminate the forces that tend to correct the strain, the deflection or twist will again assert itself.

The forces employed to straighten out a bedplate under these conditions may sink the wedges under special pressure, down into the foundation while grouting is in progress. An unsatisfactory alignment will then be produced after the grouting has set. Misalignment may occur, although correct alignment was produced originally, if slight vibration caused by the turbine or auxiliary parts, or by the plant in general, should allow the wedges that carry the excessive weight to work loose; in the case where wedges are withdrawn, an excessive local weight or force may loosen a portion of the grouting, which would eventually allow the machine to settle and become out of line. It is, therefore, most important to handle the bedplate carefully, so that no undue strains or permanent sets are introduced.

When the second operation, or that of careful leveling is completed, which comes after the first operation of bringing the machine to the proper elevation, it may be found that the side alignment of the bearings or other elements are somewhat out, due to such permanent sets, which may not be apparent from the leveling pads or other surfaces. In order to bring proper side alignment without loss of time, this is sometimes forced by placing a jack against the member to be adjusted, so as to push it in proper alignment. The leveling will then appear to be seriously out in one or more places, which could not be passed as a satisfactory job of installing. It may become necessary to change distribution of wedges or bolt pressure in order to bring correct side alignment and correct leveling at the same time, and still the item of proper elevation must be carefully adhered to. With these three conditions—elevation, leveling and alignment to make satisfactory, it is a long journey to make ready for grouting.

Shims Possess Advantages Over Wedges

These many difficulties have been overcome with success, satisfaction, stability and speed by providing an approximately level plane surface composed of iron blocks for the support of the bedplate. Undue strains are avoided when the bedplate is set on such supports or an assembled turbine is placed thereon. Proper elevation can now be obtained by placing shims of the proper thickness between each block and the bedplate. It may be possible to pick up an entire unit of medium size with a crane if there are facilities for doing this, without introducing undesirable deflections in the bedplate; in such a case the proper shims, each one of an equal amount, can quickly be inserted. In other cases wedges may be used for lifting up the bedplate in order to insert the shims and then withdrawn. It will be seen that the amount of wedging can be readily gaged by the amount that the bedplate lifts off the iron blocks, and undesirable stresses can, therefore, be easily avoided.

Fig. 1 illustrates the use of these iron blocks, which are cast-iron plates 6x8x1¼ in., supported by ¾-in. bolts.

It will be seen that a block may be quickly leveled with a screwdriver used on the supporting bolts, and the entire plane surface can be produced by leveling each block with its neighbor by means of a straight-edge and level. With a sensitive level these can be brought up to an approximate plane surface very easily. If a carpenter's level is used, it will be impossible to secure a satisfactory plane surface with any amount of labor, as it is not sufficiently accurate. Drill each corner of a

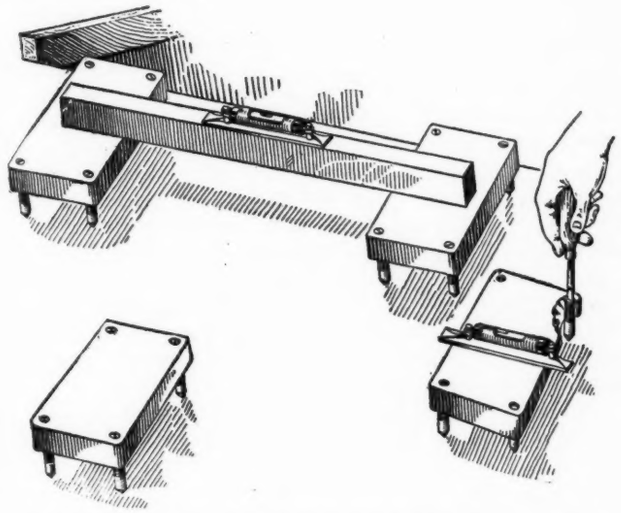


FIG. 1—A PLATE IS EASILY LEVELED BY USING A SCREWDRIVER. BRING ALL PLATES TO THE SAME ELEVATION WITH STRAIGHT-EDGE AND LEVEL

block with a $\frac{19}{64}$-in. drill, and tap for $\frac{3}{8}$-in. thread. Studs can be made by threading a long $\frac{3}{8}$-in. rod from standard stock and then cutting it into proper lengths and slotting one end for the screwdriver with a hacksaw. The head of each screw should be below the upper surface of the block when it is mounted in position. The length of the studs should, therefore, be calculated beforehand, so that they will not be too long when the turbine is properly leveled.

After the blocks have been set in place, as required for proper distribution of the weight, special attention being paid to the turbine cylinder or wheel casing, and the generator, so that there will be ample support for these heavy weights, a dam should be built around each individual block and grouting carefully poured in; after setting two or three days, the bedplate may be placed thereon. Fig. 2 shows these blocks leveled and grouted for the bedplate of a turbine unit. In addition to the advantages before mentioned for such plane surfaces, it will be seen that the turbine can be moved in a horizontal direction without disturbing its leveling appreciably, and if such a movement should take place at any time in the future, it would not represent as serious an effect on the alignment as if the bedplate were supported on wedges. It is also comparatively easy to move a bedplate or a turbine generator unit on an iron surface that corresponds to a plane, whereas any horizontal movement, when set on wedges, will immediately produce improper leveling and misalignment. This is a great advantage when adjusting to the position to the center lines required by the station layout.

The cost of these cast-iron plates is very low, considering the satisfaction, speed and reliability that they produce in the operation of installing. The time required for machine work, leveling and grouting is often much less than that required in leveling and aligning the base of a large turbine with the use of wedges; often the time in erection can be greatly reduced. The blocks may be made up in a foundry if desired, or plates of rolled steel, one inch thick or thereabouts, may be substituted for cast iron if it is more convenient to make them up of this material. When plenty of stock and means of quick cutting are available, steel is often cheaper than cast iron.

In case it is necessary, for emergency reasons, to operate a unit without grouting, it is very probable that if such blocks are provided in advance, operation for considerable periods can be maintained to better advantage than when placed on wedges.

The plates should be arranged flush with the sides of the bedplate or very nearly so, in which case they will not interfere with the finishing of the floor in the way that wedges often do, as the latter may stick out considerably beyond the bedplate and sometimes are in such a location that they cannot be sawed off or cut shorter. It often happens that there is a certain amount of looseness between the foundation and the bedplate, and if wedges are removed in order to tighten at such a point, the alignment is sometimes seriously changed. It should be borne in mind that the grouting at first expands slightly and then, when it has permanently set, has undergone a certain amount of contraction, and usually is slightly smaller than the original space. The grouting, therefore, between the foundation and the bedplate should not be greater than $1\frac{1}{2}$ in. thick at any point. Grouting carefully made, and as high as possible inside the base, will tend to hold the bedplate down toward the foundation.

Preparations for Grouting

It is necessary to build a dam in order to grout in, after the unit has been brought to the proper elevation and alignment with itself, as well as in respect to the center line required by the design of the station. The location of the steam and exhaust openings to the condenser and header, respectively, and also drain piping, air ducts and conduits for the generators, etc., should be checked. A convenient method of building such a

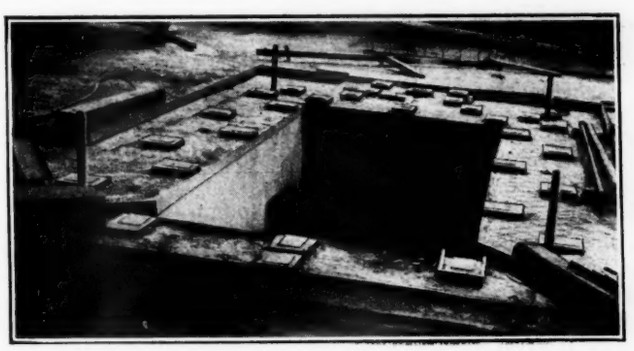


FIG. 2—PLATES GROUTED ON FOUNDATION READY FOR THE BEDPLATE OF A TURBINE UNIT

dam is to make a fairly stiff mixture of equal parts of fine sand and cement and plaster between the foundation of the bedplate with this material. After setting overnight, the main grouting can then be poured. Material for the dam is a rich mixture and therefore a first-class material for grouting, and consequently there is no objection to leaving this plastering in place.

The grouting that is first poured in the bedplate should be of an especially thin and easily flowing consistency, so that it will run into small places and make a good joint with the concrete of the foundation and dam. It is customary to wet the foundation before grouting. The floor can easily be finished when blocks and a dam of this kind are used, with the addition of making a neat appearing job.

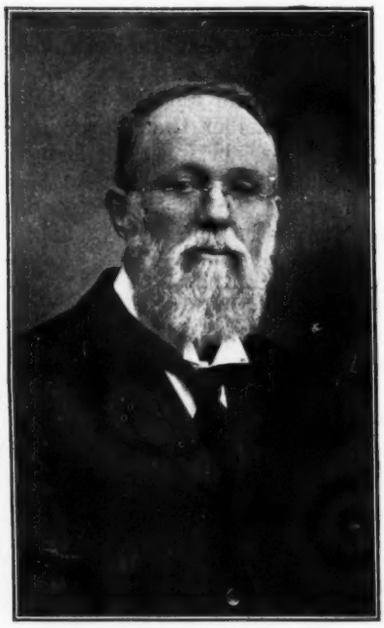
Backwoods Engineering

Reminiscences of the Early Struggles of an Old Timer with Makeshift Equipment.

BY A. G. COLLINS

My first adventure in engine operating was a small slide-valve box-bed engine, probably ten or fifteen horsepower, and a horizontal boiler with two large flues, similar to the boilers then in use on Ohio River steamboats, as the power plant of a small woolen mill.

The water supply was a well in the engine room, from which the water was raised by a vertical single-acting piston pump, driven by a crank on one end of an overhead countershaft, belted to a pulley on the engine shaft. The pulley on the countershaft was a constant source of trouble. The bore was larger than the shaft—too much for one thickness of tin but not enough for two. I got the best results with horseshoe nails (which were plentiful at the village blacksmith shop), driving them in from each end of the hub, as close together as possible, and then driving the key tight. Curved iron wedges encircling the shaft, which I suggested, were beyond the skill of the village blacksmith.



ALONZO G. COLLINS

If the pulley had been setscrewed instead of being keyed, I think I would have had less trouble, as the changing resistance, due to the pump being single-acting, would finally loosen the key and then—more horseshoe nails. The well pump discharged into a wooden tank located above the boiler and was the general water supply for the mill.

The boiler-feed pump was a horizontal plunger pump, discharging through a pipe coil in a closed heater bolted to the side of the engine bed, the plunger connected to a projection of the engine crosshead. Thus the pump had the same stroke and speed as the engine, but as the engine made only seventy revolutions per minute, the pump gave no trouble but was noisy, as the feed was regulated by throttling the suction and the pump was usually only partly filled with water.

The whole outfit had been bought second-hand, and cheapness was the main consideration; even the exhaust pipe from the engine was just ordinary tin rainwater pipe. The upper end of the exhaust pipe was a gooseneck turned down into the water tank above the boiler, to heat the water in the tank, the top of the tank being covered and with a vent pipe extending above the roof. The end of the exhaust pipe was not intended to be submerged in the water, as it projected but a few inches below the top of the tank, so that all the water heating was done by the steam blowing against the surface of the water, but it did better than one would expect.

Of course I did the firing. Cordwood was the fuel, and to facilitate starting a fire in the morning, after shutting down at night I would throw a couple of large sticks back against the bridge wall, push the remaining coals over them and cover the whole with five or six inches of ashes from the ashpit, and in the morning rake down a fine mass of live coals. Also, after shutting down at night, I would open the boiler-flue doors and fill the two large flues with small sticks of cordwood, leaving the flue doors open and the firing doors shut, close the ashpit openings with two handy pieces of sheet iron, and the heat from the water in the boiler would put the wood in fine condition to spring into a blaze as soon as it was thrown on the live coals.

I worked at this place only one summer, so I don't know how they managed to keep things from freezing up in the winter, as the front end of the boiler and engine room was open to the weather.

TAKES CHARGE OF COUNTRY FLOUR MILL

My next job was with a country custom flour mill, with a 14x28-in. slide-valve box-bed engine and a 56-in. by 18-ft. boiler with two 15-in. flues, for a power plant. The engine shaft was geared by bevel gears to a vertical shaft, which in turn, by a large wooden-toothed spur gear gearing into cast-iron pinions, drove the vertical spindles of the millstones.

The boiler feed was a vertical plunger pump driven by a walking beam on one end of a shaft, carried in bearings on A-frames bolted to the top of the engine bed each side of the crosshead guides. From this shaft a lever dropped to a link connected to the crosshead of the engine. The pump took its suction from an open feed-water heater bolted to the side of the engine bed.

A dam had been built across a small stream, forming a pond, which supplied water for the boiler, under a head sufficient to flow to the feed-water heater, but not enough to fill the boiler when it was empty after cleaning. The mill was about 150 ft. below the dam, and this space was used as a logyard for a small sawmill, which was run in connection with the gristmill.

There was no water under pressure for washing out the boiler, so the program was to let water out of the boiler through the blowoff until it was about halfway down the flue, then close the blowoff, enter the boiler, and with a stiff broom wash the mud and loose scale from the top of the flues and the sides of the boiler, and then open the blowoff, and beginning at the front end of the boiler, brush the sediment and scale on the bottom from the front to the blowoff, the flow of water through the valve carrying all the scale and sediment with it.

To fill the boiler after cleaning, there was a wooden V-shaped trough, made in about twelve-foot lengths, with "X" supports at each length, reaching from the open manhole of the boiler across the log yard, to a platform over the water above the dam, on which to

stand and dip up water with a bucket and pour it into the trough until the boiler was full. I had not done this job many times until I knew the number of bucketfuls it took to fill the boiler, and that saved me a good many trips to find out how the filling progressed. On account of its interfering with the handling of logs, this trough had to be put up and taken down whenever it was used, which was every Monday, as that was boiler-cleaning and millstone-dressing day. Of course it leaked, but a peck of bran judiciously sprinkled in the bottom stopped the most of that.

Iron Ring Wound with Hemp Packing Used for Manhole Gasket

For manhole gaskets the usual thing was a wrought-iron form made of about ¼x1-in. iron, which was bent the flat way to the shape of the manhole, the inside about one inch larger than the manhole opening and the ends welded. Hemp packing (which, except candle-wicking, was the only packing available in those days) was unstranded, and taking one strand at a time it was wound tightly around the form until the hemp was built up about one-fourth of an inch thick. The usual practice was then to smear white lead all over each side, but this made cleaning it off very difficult, so I experimented a little and found that wetting the hemp with water, after it had been wound on the form was just as reliable as the white lead. Of course the old hemp had to be cleaned off and new hemp applied every time the joint was broken.

The flywheel of the engine was about fourteen feet in diameter, and of peculiar construction, the only one of its kind I ever saw. The hub, arms and rectangular rim were all cast separately, and the flange of the hub had sockets cored in it for the inner ends of the arms, and the inside of the rim (which was cast whole) had inwardly projecting hubs, which were cored for the outer ends of the arms. These cored holes had a clearance all around of roughly half an inch larger than the arms, and the holes in the hub were deep enough to allow the outer ends of the arms to clear the hubs in the rim for erection. After the rim was in place, the arms were pushed into the rim sockets and taper keys driven through the hub, contacting with the inner end of the arms holding them from radial displacement, and allowing for radial adjustment.

Flywheel Trued up with Iron Wedges

The clearance around the arms in the sockets was filled with iron wedges, by a judicious manipulation of which the rim could be trued up. Considering that the only machine work on the wheel was boring the hub, the result was fair, the rim being probably not more than half an inch out of true.

The mill was of frame construction, and it took some scheming to prevent frozen pipes at night when the mill was shut down. The low places in the boiler-feed pipes had plugged openings instead of drain cocks, and these plugs had to be taken out at shutting-down time, and replaced in the morning. The caps on the valve chambers of the boiler-feed pump had to be removed and the valves taken out, as, although the pump could be drained enough to prevent damage from freezing, there would be enough water lying around the valves to freeze them to their seats, and that would prevent the pump from working. There was no stop valve at the boiler, on the steam pipe to the engine, and as there was five or six feet of vertical pipe above the throttle valve on the engine, in which the condensation could freeze, I would set the engine on dead center, open the cylinder cocks and crack the throttle valve, thus letting a little steam blow through the cylinder, as long as there was any pressure in the boiler. Of course I would pump up a good supply of water in the boiler, to make good the loss during the night. I ran this plant several years and never had a damaging freeze-up, and the time required to remove and replace the pump valves and pipe plugs was a regular part of the day's work.

Transformer Designed To Prevent Oil Explosions

Large quantities of insulating oil are used in power transformers. While this oil is specially prepared for the purpose and ordinarily represents a very small fire and explosion risk, it sometimes happens that peculiar combinations of circumstances bring about rather serious explosions with transformers as heretofore constructed. The Westinghouse Electric & Manufacturing Co. has developed a power transformer that incorporates an entirely new principle in design, claimed to obviate any possibility of the explosions that sometimes occur in large transformers.

This new principle consists in filling the transformer case above the oil level with nitrogen, which is an inert gas incapable of forming an explosive mixture with vapors arising from the oil. The nitrogen gas used is generated in a device of simple design which is attached directly to the transformer tank. This generator works automatically to keep the space above the oil level always full of nitrogen. No oxygen, which is the element needed to produce explosions or start a fire, can enter or be present in the tank. An important feature of this design is that the inert gas above the oil level acts as a cushion or buffer to take the shock of any sudden pressures that may develop under the oil if there should be a short-circuit in the transformer windings. An electric arc under the oil level, if it should occur, can produce a tremendous pressure in the tank. The sudden impact of this pressure against the walls and cover of a tank that is completely full of oil, has been known to burst the tank and cause a serious interruption of service. This cushion of nitrogen gas is easily compressed, and it is enough of a buffer to take the shock of the explosive pressure and save the tank from injury. A 25,000-kva. bank of these transformers is to be installed in the Grand Tower, Ill., station of the Middle West Power Co., for which Sargent & Lundy are the consulting engineers.

What CO_2 really shows is the amount of excess air going up the stack. The stack gases constitute a sort of hot-air system for warming up the sky. The more hot gas going up the stack, the greater is the loss of sensible heat (heat that can be felt). There is a certain minimum of air that must be used to get complete combustion with a given coal and furnace. Anything beyond this represents avoidable waste, a waste that often amounts to 15 or 20 per cent of the entire coal bill in plants that are supposed to be well operated. When burning a certain weight per hour of a given coal, the total *weight* of CO_2 produced per hour must be constant, but the *percentage* of CO_2 in the flue gases will depend on the total weight of the flue gases. If the weight of flue gases is doubled, then the same weight of CO_2 will only be half the former percentage of the total.

Easy Lessons in Engineering

How To Avoid Mistakes in Arithmetic

[This is the first of a series of simple articles on fundamental engineering principles and their applications.—Editor.]

In making practical computations the wrong answer is far worse than no answer at all. In general there are five methods of checking, which are as follows: (1) Repeat the computation, taking exactly the same steps as before; (2) repeat the computation with a new series of steps; (3) work back from the answer to get the original data; (4) make a rough check by mental arithmetic, using approximate values; (5) see if the answer obtained agrees with common sense.

Let us illustrate these methods by some simple operations in arithmetic. Suppose, first, that we wish to total the following column of numbers:

243.3
794.5
865.7
927.3
1,264.5
Total 4,095.3

Let us assume that in the original addition we start at the top of the right-hand column of digits and add down as follows: "Three, eight, fifteen, eighteen, twenty-three." We then put down the 3 and, carrying the 2 over to the next column, start adding down: "Two, five, nine, fourteen, etc." If the total obtained in this way is checked by repeating the original operations exactly, it is possible to repeat a mistake.

To avoid this, check by adding in the opposite direction. In this case the original addition was downward, so the check should be made from the bottom up, starting "five, eight," etc., with the right-hand column.

With the ordinary method of adding up a column of numbers, it is necessary to start again at the very beginning if a mistake is made in carrying over or in adding any column of digits. This can be avoided by putting the total of each column on a separate line as shown below:

243.3
794.5
865.7
927.3
1,264.5
2.3
23
27
28
1
4,095.3

This method of adding makes it possible to check the addition of each column of digits separately and correct any that are wrong without disturbing the rest.

Subtraction is most easily checked by addition, as illustrated by the following example:

Problem and solution	Check
896	252
−252	+644
644	896

The following example shows how division may be checked by multiplication:

Problem and solution	Check
$1{,}134 \div 27 = 42$	$27 \times 42 = 1{,}134$

Multiplication may be checked by division, but it is easier and equally satisfactory to multiply again in the reverse order, thus changing all the operations. This is illustrated by the following example:

Problem and solution	Check
792	265
× 265	× 792
3960	530
4752	2385
1584	1855
209,880	209,880

As mentioned at the start, the result of any computation can also be roughly checked by mental arithmetic and by common sense after one or more of the exact checks have been made.

To illustrate the application of these checks, suppose that it is desired to figure the weight of a cast-iron plate 2 in. by 16 in. by 24 in., taking the weight of cast iron to be 0.26 lb. per cubic inch. The weight of the plate will then be the product $2 \times 16 \times 24 \times 0.26$. This may be worked out in various ways. Suppose it is done as follows:

16	.26	6.24
× 2	× 24	× 32
32	104	1248
	52	1872
	6.24	199.68 lb.

The first check might be to multiply the same numbers in a different order as follows:

.26	24	384
× 2	× 16	× .52
.52	144	768
	24	1920
	384	199.68 lb.

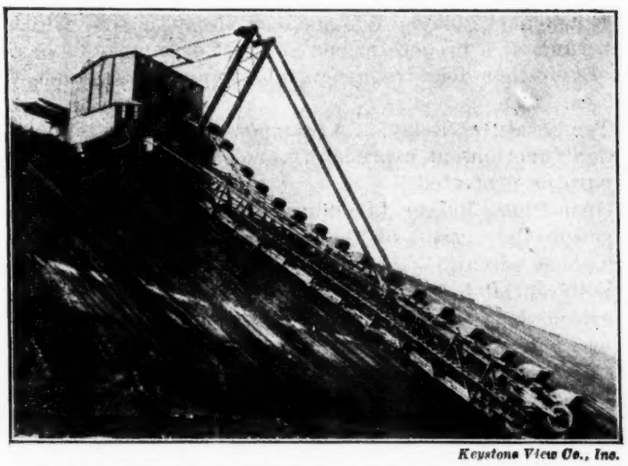
By approximate mental arithmetic we have, say, $2 \times 16 \times 25 \times \frac{1}{4} = 2 \times 4 \times 25 = 2 \times 100 = 200$ which proves that no large mistake has been made. The common-sense check consists in stopping to consider whether it is reasonable for an iron plate of these dimensions to weigh approximately 200 lb.

German Brown Coal Compared With Our Lignite

COLOGNE brown coal is almost two-thirds water, ours one-third; German product has 2½ to 13 per cent agglutinating matter, ours less than 1½ per cent; brown coal soft, ours a mineral.

BY O. P. HOOD*

ALTHOUGH I had read many reports about the brown-coal industry of Germany, actual inspection gave me several impressions for which I was not prepared. We had fallen into the careless habit of thinking about German brown coal and American lignite as similar material. The great briquetting industry which has been built upon German brown coal has been frequently pointed to as an example of what we should do with our own lignites. This puts one in a frame of mind to expect a greater similarity in raw material than actually exists.



Keystone View Co., Inc.

CHAIN BUCKET CONVEYOR DIGGING BROWN COAL

This coal deposit is so soft that it can be dug like sand by a dredging bucket or "landbagger." Note the soft partings in the coal and the smoothness of the excavated surface. This system would work with American or other peat but not with American lignite. This illustration is from a photograph made in the Nieder Lausitz district.

Analyses of the two materials indicate a great difference in water content. Our lignite has approximately 35 per cent moisture, whereas German brown coal in the Cologne district has about 60 per cent. Along with this difference in the moisture content is a considerable difference in physical character. Brown coal is much more like earth than like rock. It is far less consolidated than our lignites. We would not think of trying to force a spade into a bed of our lignite, but this would be quite possible with much of the German brown coal.

A piece of brown coal slightly consolidated and 3 in. thick is readily broken with the fingers like a piece of corn bread. Throughout a mass of brown coal small pieces of wood are much in evidence. The binding material between the annual layers of wood growth has almost disappeared, leaving the thin chips to curl and crumble when exposed to the sun. One small pile of brown coal exposed to the weather for a couple of months has the appearance of a chip pile.

These woody pieces have turned a dark chocolate brown, and they have various degrees of friability. Occasionally large chunks of wood are found that would offer considerable resistance to any digging device. The beds in various places vary in the proportion of fine and coarse material but in general the material is distinctly earthy. When taken to the briquetting plant the brown coal is passed over screens which take out pieces over about 3 in., and these are diverted to the boiler house for steam making.

The remaining material above ½ in. is readily broken up in a disintegrator. Our own lignite would have to be put through rolls or a jaw crusher. The vegetable growth that furnished these great beds varied from time to time, so that in some places there is a distinctly banded appearance, the color varying from various shades of chocolate brown to a light yellowish brown. In mining by hand the material is easily dislodged with pick and shovel. Blasting seems unnecessary, and the excavating machinery scrapes it off a steeply inclined face.

Beside these physical differences there are important chemical contrasts. Certain materials in brown coal, on being heated, form an excellent binder and waterproofing material. The temperature at which this material develops is well below that of the distillation of any of the other coal substances. The percentage of this binder in the raw material must be at least 2½ per cent if briquets are to be produced by the German method. This method, briefly, is to subject the brown coal, which has been dried to a moisture content of about 13 per cent, to high pressure, pushing it through a converging die which generates sufficient heat by friction to melt the inherent binder and thus waterproof each particle. Different brown coal beds possess this natural binder in varying quantities up to more than 13 per cent.

The low-temperature distillation of this material yields lubricating greases and paraffin from which candles are made. Most of our American lignites have binding material of this sort in quantities less than 1½ per cent. This immediately suggests that our own problem of briquetting is fundamentally quite different from that of the German brown-coal area. We are quite justified in looking to the development of the brown-coal industry as an excellent example of what can be done when it is necessary to beneficiate a low-grade fuel, but we are not justified in looking to this example for specific technical detail as a solution of our own lignite problem.

America has a lignite problem that must be solved in our own way to fit our own raw material and to suit our own economic conditions. The German brown coal occurs in well-populated districts where there is a high degree of industrial development coincident with a scarcity and relative high price of other fuels. It is in the possession, also, of a people who have not always had

*Chief mechanical engineer, U. S. Bureau of Mines.

the choice of an abundance of the best coal and who have already acquired an attitude of thriftiness toward the use of heat.

Our own lignite occurs in districts furnishing a far less concentrated market and a much smaller degree of industrial development, and where the distances from coal field to a market are much greater. Our lignite also occurs among a people quite familiar with some of the best coals on earth and with habits of using heat in quantity, particularly for domestic purposes, quite unknown to European habit.

The brown coal industry of Germany at the present time is rapidly developing, as a result of the scarcity of industrial fuel. There is a real shortage of fuel which can be met in the most expeditious manner by the development of brown coal. While a relatively small percentage of Germany's total fuel resources are in the form of brown coal, they are turning to this portion for rapid development at this time. There is enough of this material to last from eighty to a hundred years, and the methods of mining and treating have been developing since about 1856, so that practices are substantially standardized and can be applied with little risk and uncertainty.

In 1921 the total output of brown coal was 123,000,000 tons, while more than 28,000,000 tons of briquets were produced. The raw brown coal is used for industrial purposes on step grates, but since it has only from 3,200 to 4,500 B.t.u. per pound, it is quite evident that it cannot be transported any great distance, except under extreme need. The briquets, on the other hand, make a most excellent fuel for industrial and domestic consumption.

It takes about three tons of brown coal to produce one ton of briquets, one ton of the raw material being required to reduce the remaining two tons to one of briquets. Their heat value is about 8,600 B.t.u. per lb.

Relay Nomenclature

The following list of relay nomenclature was adopted recently by the Electric Power Club and is to be inserted in the club's handbook under "Nomenclature":

Classifications by Functions

General. Where relays operate in response to changes in more than one condition, all functions should be mentioned.

Electric Protective Relay. An electric protective relay is an intermediate device, equipped with contacts to open or close an auxiliary circuit, by means of which one circuit is indirectly controlled by a change in conditions in the same or other circuits.

Overload Relay. An over-current relay in the circuit of a motor is one which functions at a predetermined value of the current to cause the disconnection of the motor from the line.

Directional Relay. A directional relay is one which functions in conformance with direction of power, or voltage, or current, or phase rotation, etc.

Power-Directional Relay. A power-directional relay is one which functions in conformance with direction of power.

Note: This includes both uni-directional relays with single-throw contacts and duo-directional relays with double-throw contacts. The reason this name is preferred to "reverse power" is that the device is frequently used to function under normal direction of power. Furthermore, in some cases the normal condition of the system may permit power to flow in either direction. Relays for use in either alternating- or direct-current circuits are to be classed as power-directional relays.

Polarity-Directional Relay. A polarity-directional relay is one which functions by reason of a change in direction of polarity.

Phase-Rotation Relay. A phase-rotation relay is one which functions by reason of a change in direction of phase rotation.

Current Relay. A current relay is one which functions at a predetermined value of the current. These may be either over-current relays or under-current relays.

Voltage Relay. A voltage relay is one which functions at a predetermined value of voltage. These may be either over-voltage relays or under-voltage relays.

Power Relay. A power relay is one which functions at a predetermined value of watts. These may be either over-power relays or under-power relays.

Frequency Relay. A frequency relay is one which functions at a predetermined value of frequency. These may be either over-frequency relays or under-frequency relays.

Temperature Relay. A temperature relay is one which functions at a predetermined temperature in the apparatus protected.

Open-Phase Relay. An open-phase relay is one which functions by reason of the opening of one phase of a polyphase circuit.

Differential Relay. A differential relay is one which functions by reason of the difference between two quantities such as current, or voltage, etc.

Note: This term includes relays heretofore known as "ratio-balance relays," "biased," and "percentage differential relays."

Locking Relay. A locking relay is one which renders some other relay or other device inoperative under predetermined values of current, or voltage, etc.

Trip-Free Relay. A trip-free relay is one which prevents holding in an electrically operated device such as a circuit breaker, while an abnormal condition exists on the circuit.

Auxiliary Relay. An auxiliary relay is one which assists another relay in the performance of its function and which operates in response to the opening or closing of the operating circuit.

Signal Relay. A signal relay is an auxiliary relay which operates an audible or visible signal.

General Qualifying Terms

Inverse Time. Inverse time is a qualifying term applied to any relay, indicating that there is purposely introduced a delayed action, which delay decreases as the operating force increases.

Definite Time. Definite time is a qualifying term applied to any relay indicating that there is purposely introduced a delayed action, which delay remains substantially constant regardless of the magnitude of the operating force. (For forces slightly above the minimum operating value the delay may be inverse.)

Instantaneous. Instantaneous is a qualifying term applied to any relay indicating that no delayed action is purposely introduced.

Notching. Notching is a qualifying term applied to any relay indicating that a number of separate impulses are required to complete operation.

EDITORIALS

F. R. LOW, EDITOR

Learning the Fundamentals

DIFFERENT men have different needs, but there are two elements that may be listed as invariable requirements for the making of an all-around engineer.

One of these is a practical working knowledge of power-plant operation. This is obtained mainly from the three following sources: Personal experience, technical journals and contact with fellow engineers. The other is a knowledge of fundamental principles, which can be obtained only by study. A man who does not study may work for years in a power plant and still get no real understanding of what is taking place in the boilers, engines and others equipment under his care.

Although some operating engineers have had the advantage of attendance at a resident technical school, the average man in this field must work out his own salvation by the sweat of his brow. Such a one can console himself by the thought that what a man digs out without a teacher he usually learns more thoroughly.

But the practical engineer who studies without a teacher should use material specially prepared for his needs. Suppose, for example, that he wants to learn something about algebra and trigonometry and starts to study the regular school textbooks on these subjects. Except for the "mental exercise" he gets, the chances are that his time will be largely wasted, because such textbooks are full of material that has little practical application. Buried, however, in the mass of "sand" are a few golden nuggets, and there is no good reason why the practical engineer should not be allowed to take the gold and leave the sand for the folks with more time on their hands.

With the idea of helping the man who desires to brush up on those fundamental principles that underlie all practical engineering work, *Power* is starting with this issue a series of easy lessons in engineering. The initial article, "How To Avoid Mistakes in Arithmetic," is designed—as are those that will follow—to show the reader how to make practical application of each principle as soon as it has been explained.

Improving Reliability of Main Units

THE necessity for reliability is greater in large than in average-sized units both on account of the greater investment involved, since those for central stations are about ten times the capacity of units for the average manufacturing plant, and also because service requirements are more severe. When large units carry the base load, operation is desired ninety-five per cent of the year. This means that the prime mover, generator and condenser must each have a capacity for operation of better than ninety-five per cent, for if five per cent of operating time is absolutely required for inspection and repairs of each of the three elements, then in order to realize ninety-five per cent unit operation, the attention must be given to condenser, prime mover and generator at the same time, when the entire unit is shut down.

In ordinary practice the necessity for such repairs would never occur simultaneously, requiring exactly the same time interval. It is possible, therefore, to realize the desired operation only when there is a considerable reserve of reliability so that all three elements are not vitally dependent on five per cent operating time for repairs.

In medium-sized units, particularly in manufacturing plants, there are sometimes seasons where the load is greatly reduced so that considerable time for maintenance and repairs is available. On the other hand, there are many more units of medium than large size manufactured, and the designs are not subject to the rapid changes necessary in central stations, where increasing capacities, steam pressures and improved economy must be dealt with.

Dependability, however, is becoming more valuable continually, so that it does not pay, strictly speaking, to let "well enough alone," and wait calmly for the inevitable period of repairs. The high capacity for operation can be maintained only by eternal vigilance. This means regular and rigid inspection by experienced and often skilled men.

There are, in general, three ways of improving reliability. The first, or general, method consists of bringing pressure to bear on the manufacturer or operating force, so as to produce a general "tightening up." Such a condition usually follows a siege of trouble, and may be due to inability from financial reasons, lack of material, inadequate management, etc., to take the proper preventive measures. It may or may not be equal to the occasion, depending on the quality and extent of such a spasmodic effort.

The second method, however, is more important. This is to note carefully the faults or troubles that show up in operation and see that proper means are taken for preventing such occurrences in the future, whether this entails improvements of design, manufacture, adjustment or operation. It has been notable in the last few years that users or purchasers of prime movers and driving equipment of all kinds have been active in conferring with the manufacturers regarding faults that have developed in order to see that the product is standardized or improved, and operating requirements better understood.

A third method, involving a somewhat more difficult task, lies open for future improvement of machinery. This consists in making a study of the faults or troubles that occur, and have not made themselves felt seriously by the users or the manufacturers, but present a possibility of future trouble. This method does not appeal to the manufacturer or operating head, as in general it does not show up on the expense account of manufacturing, installing or operating and represents only potential loss. Complaints or suggestions by a man directly concerned in adjusting or operating are

given weight only in accordance with the ability of the man to make his report felt. It often happens in a new type of machine that some feature gives trouble in one or two plants, while possibly the first two or three machines had operated without trouble in this respect. We might say, for example, that friction exerted by a fiber packing gland on an emergency valve or governing part interfered with the proper operation at times. If the first few complaints were disregarded, such as might have been made by the man making the installation, it is more than likely that within a year or two there will be a large number of complaints representing a certain proportion of the large number of machines sold and operated with that particular construction. As many of us know, losing a considerable sum of money as a result of such troubles will usually convince the manufacturer or operating head that changes are desirable. On the other hand, occasionally a gratifying example is seen where the first authentic complaint that can be remedied by a reasonable improvement, is seized upon as a means of developing an improved product. Under certain conditions a labyrinth packing gland might result in a cheaper and more reliable construction than the packing mentioned before. The application of enterprising investigation has in some instances placed in the hands of a manufacturer improvements that resulted in his product being notably superior to that of his competitors.

Analyzing the resulting operation may appear to the onlooker to be far from the purposes of many manufacturers or operators. In the effort to meet competition, complaints are seldom sufficient to justify investigation unless there is a direct response or result involved. The ability to use the results of such conditions sometimes calls for a skilled practical experience which is not necessarily characteristic of highly educated designers. The way lies open, for those who possess the initiative and ability, to secure improved reliability and perhaps other benefits by investigating conditions at hand. Gratifying examples sometimes occur where the ideas of the "man on the job" have been utilized in some form with benefit, which indicates that more activity along these lines may be expected in the future.

Water Power and the Coal Problem

IT IS estimated that there is in this country fifty million horsepower of undeveloped water power that can be utilized by present methods of development, and that making these resources available for industry, the railroads and domestic uses, would save four hundred millions tons of coal a year. No wonder, then, that whenever there is a coal shortage a great deal of attention is directed to our water-power resources. However, the development of hydro-electric power, even after everything is ready to go ahead with the actual work on the project, requires anywhere from one to three years or even longer to carry it to a state of completion where electric power can be produced on a commercial scale. Therefore, if these resources are not available before a coal shortage occurs, they probably will not be during the crisis.

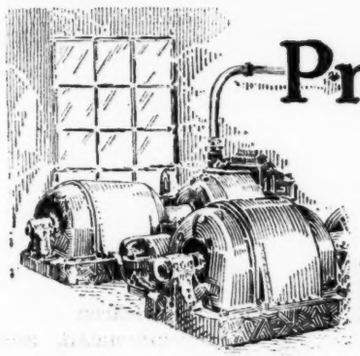
Since the Federal Water Power Act became a law over two years ago, a great stimulus has been given to water-power development in this country. However, experience has shown that something more than favorable legislation is required in many of our large water-power developments. Many of these are involved in international and interstate politics. There is some nine million potential horsepower on the Niagara and St. Lawrence waterways which requires a joint agreement between the United States and Canada for development. On the Colorado River, with its six million potential horsepower, an agreement among seven states, as well as the consent of the federal government is required before it can be developed. Other water powers throughout the country are in similar circumstances.

After the political entanglements are cleared away, financing of the project must be consummated, and experience has shown that this cannot always be done where the development has to compete with a steam plant. Even where power can be developed at the site at a reasonably low cost, the expense involved in transmitting it long distances to a market frequently precludes the development. These are only a few of the difficulties that stand in the way of replacing steam power plants with water power and relieving the country of the menace of a coal shortage.

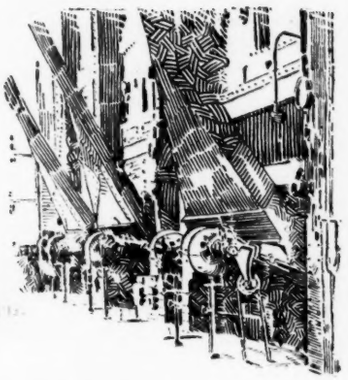
Although this country has extensive water-power resources, they can never be expected to replace steam-electric stations, but only to supplement them, except in some few locations. Even if water-power developments continue at the present rate, the building of steam plants will have to be carried on at an ever-increasing rate to keep pace with the demand for power. When solving the coal problem by developing water power is suggested, two very important factors are overlooked; namely, that the demand for power is increasing at a rate that doubles its consumption about every ten years and that the use of coal for industrial and domestic purposes is also increasing at a rapid rate. Therefore, if some conjurer could, with a wave of his magic wand, bring all the water powers into use and relieve our present coal difficulties, it would only be a matter of a few years until our power demand would equal or exceed our water power and we would find ourselves in worse circumstances than before the waving of the wand. Since, then, power demands would have to be met entirely from our fuel resources, the coal problem cannot be solved by any substitution and the sooner this is realized and the problem given the attention its importance demands the sooner the country will be out of one of its serious difficulties.

January fifteenth is the date specified for the preliminary report of the President's Coal Commission, and as the time approaches, much interest is being manifested as to what the Commission is likely to say. While the report will probably contain many pertinent deductions from the evidence thus far collected, the public must not expect too much of a definite nature at this stage of the inquiry; for not only has the time been short compared with the immensity of the problem, but the funds have been limited.

Regulation of utilities by public-service commissions has now become an established practice in nearly every state, accepted by both the public and by the utilities. To again subject the matter of rates and service to the mercies of local political bodies, such as is advocated by Governor Smith for New York City, would strike a blow at the foundations of utility regulation and revert to a pernicious practice which it took years to get rid of.



Practical Ideas *from* Practical Men



Why the Oil Pump Gave Trouble

I once was given the job of locating some trouble on a duplex oil pump. The pump would lose its suction and race. It had been sent to a machine shop and overhauled, but still gave trouble. Upon investigation I found that the suction valves were not seating properly.

I used a scraper on the brass disks until they all seated as they should. Upon trying out the pump, the suction was found to be all right, and the cause of the racing had been removed, but the pump would stop occasionally. This was due to its becoming gas bound. There was a $\frac{1}{32}$-in. hole in each of the discharge valves originally, but the shop, in overhauling the pump had soldered these up. After these were drilled out, there was no more trouble.

San Jose, Calif. ROY E. GRAVES.

Careful Tests Should Precede Extensive Repairs

The ease with which electrical troubles can be incorrectly diagnosed will be apparent from the following: During a thunder storm a single-phase transformer became inoperative, and at the conclusion of a rough test it was assumed that the winding was damaged, and all available men about the station were set to work to dismantle the unit. After the transformer was completely dismantled, no indication of trouble could be found, and further testing disclosed that a conductor had burned apart in one of the high-voltage outlet bushings, thereby causing the trouble.

It appears that in this case, and all others where any amount of repair work is contemplated, the time spent in making suitable tests may result in a decided saving of time and money. RALPH BROWN.

Belden, Calif.

Filing Mechanical Data

A great many articles have been published on filing and indexing clippings, but so far none has touched on the system which I have used for many years and which I think has many advantages.

I have never filed any clippings, but every number of *Power* for years back is stored away on shelves in our storeroom. But before they are placed there, every article large or small that is of interest is removed and filed away in the following manner:

The standard 9x12-in. page or pages that the article is on are removed from the number. The page is then trimmed on the two sides and the bottom to within one-quarter inch of the printed matter; if the article takes up two or more pages, they are fastened together with a clip.

I use a Shannon Lockarch Transfer Case No. 12, with a Shannon Cabinet Index. Two holes are then punched at the top of the page. All holes are punched the same distance from the right-hand side of the sheet and at such a distance that the letters in the index can be seen when the sheet is filed. All articles on engines are filed in "E," on pumps in "P" and so on with all the different subjects. Any subject can readily be found no matter how small or large the article may be.

The advantages I claim for this system of filing over others are: You can let it grow; when one transfer case is filled, another can be added; any subject can be found in the shortest time; all sheets are of a standard size and look well in the file; any article may be removed and taken to the place you wish to use it. If a friend writes you for information, you can mail him all the articles that you have on the subject in a standard envelope. If a page has two articles on the same subject, one on each side of the page, place it in the case and mark on the bottom of the page, "see other side." THOMAS J. PASCOE,

Norway, Mich. Oliver Iron Mining Co.

Reboiler Uses Waste Flue-Gas Heat

Few engineers realize the large amount of steam used in the ordinary ice-plant reboiler. On weighing the condensate from the heating coils of our reboiler, it was found to require 936 lb. of steam per ton of water boiled.

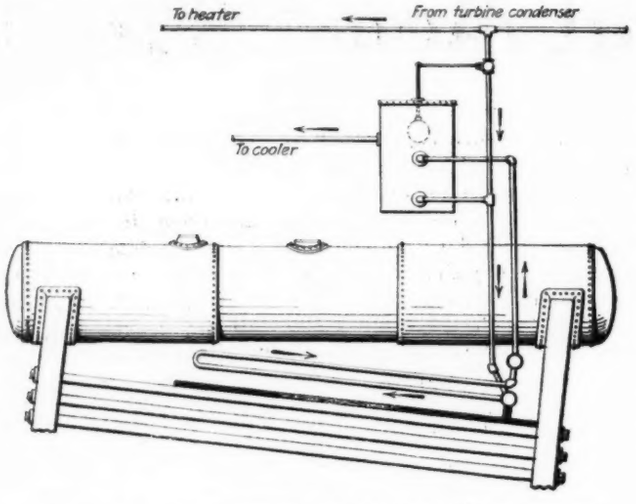
With an evaporation of 13 lb. of steam per pound of fuel oil, this represents a fuel consumption of 72 lb. per ton, and with oil at 4 cents per gal. it was costing us 36 cents per ton to reboil the water for ice making. The plant had an ordinary open reboiler with steam coils submerged and a trap to take care of the condensate, thus avoiding any loss of steam.

At the time of making this test the temperature of water going to the reboiler was 122 deg. If the water going from the condenser to the reboiler is at a lower temperature, of course the steam consumption would run a trifle higher.

In order to avoid this large consumption of steam, the reboiler was redesigned and the heat required for boiling was supplied by the hot boiler-flue gases.

The boilers are of the horizontal water-tube type. By the use of two headers, one hundred feet of 1¼-in. pipe and the necessary nipples, unions, tees, ells and return bends, a heating coil was made and placed between the top baffle and the boiler drum, the baffles being horizontal and resting on the tubes. Outside the setting above

the boiler was placed an ice can. A pipe leading to the top header of the coil was inserted in one side of the can, about halfway from the top. The bottom of the tank was connected to a pipe leading to the bottom header. In this latter pipe was placed a tee, and the condensate pipe which leads from the condenser to the feed-water heater was connected to this tee. A float in the tank controls a float valve in this supply pipe so that the water is maintained at the desired level. Tapped into the tank a few



REBOILER CONNECTED TO BOILER GAS PASSAGE

inches below the water level is a pipe leading to the cooling coils and storage tank. In this line is the hand-operated control valve, which is adjusted to the requirements of the can filler or the capacity of the apparatus. Care must be taken not to allow more water to flow than the coils will boil or the ice will show air bubbles.

This device has been used for several months, and the ice is as clear as any made with the old reboiler.

The condensate comes from a turbine, so we do not have any oil to contend with, but I am sure a skimmer could be arranged to work satisfactorily, where condensate is taken from a reciprocating engine.

Fort Myers, Fla. R. C. TRUEBGER.

Truing Commutators of Large Generators

Many articles have been published on turning down and grinding commutators of direct current generators, but they have invariably referred to small machines, and the average engineer is very much at sea when he is called upon to do a job on a machine of 1,000 kw. or over. There are many different types of machines, but the method of doing this work applies equally well to all.

Commutator troubles are found most frequently on generators used on street-railway service, and by reason of the conditions under which many plants are operated, the commutators require cutting down or grinding from time to time to keep them in good condition. This work should be done by a skilled mechanic if possible, but not every power plant has a machine shop of its own, and even though a machinist can usually be obtained from a local shop to do the work, it may be a new job to him and he must be given some instructions to get it started right.

In the illustration is shown the general position of the cutting tools when doing this work. The stand *S* that carries the compound rest and tool post of a lathe is attached to the base or frame of the machine. In some cases it may be necessary to use some blocking below the stand to bring it high enough, but generally one of the brush-holder yokes can be removed and a heavy bracket bolted on to hold the compound rest. In either case it should be rigidly supported.

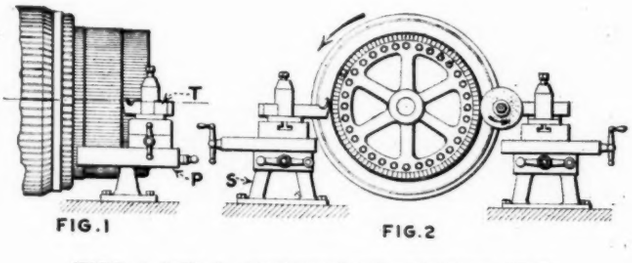
When setting the tool, care must be taken to have the carriage *P* parallel to the face of the commutator and to have the point of the tool a trifle above the center line to insure clear cutting. The tool should be made similar to a diamond point but slightly rounded.

In no case must any but a light cut be attempted, and it is well to determine about how much is to be taken off before starting the turning. This can be done by placing a straight-edge across the surface and using thickness feelers between the straight-edge and the commutator bar. Then gage the depth of the cuts so that no more will be taken off than is necessary to leave the commutator in perfect condition. Two cuts are usually sufficient (the rough and the finish).

It frequently happens with a large machine that the slowest speed at which it can be turned with the engine, will give too high a peripheral speed for the cutting tool. Where there is a motor to move the engine off the dead center, it can be used, but in some cases it may be necessary to put a belt around the flywheel and drive it with a motor. When this is done it may be necessary to disconnect the connecting rod from the crankpin.

With some types of machines the surface to be gone over is so large that often two or more turning tools are used to do the work. The rough cut and the finishing tool are both set in the same holder on the one tool carriage, or a separate stand and tool post may be placed on the other side of the commutator with the finishing tool placed upside down.

In Fig. 2 is shown a motor-driven emery grinder carried in the tool post. This is frequently used for the finishing cut in place of a second cutting tool. Some grinders are equipped with a vacuum dust-collector



FIGS. 1 AND 2—POSITION OF CUTTING TOOL AND GRINDER

attachment, and this saves considerable time in cleaning up the machine when the job is finished.

When turning down a commutator the cutting tools leave small burrs along the edges of the bars. These are best removed by hand with a stone resurfacer or by polishing with sandpaper. To do this effectively with sandpaper, the paper should be clamped to a wooden block of the proper shape to fit the commutator and fitted with a suitable handle. Use first a medium coarse paper and then finish with an extra-fine paper. This should give a satisfactory surface and polish to the commutator if the turning down has been properly done.

Cambridge, Mass. R. A. CULTRA.

Comments from Readers

Stoker Development

I read with interest the article by A. H. Blackburn on page 898 of the Dec. 5, 1922, issue of *Power*, entitled "Chronological History of Stoker Development" and marked as an extract from a paper "To be presented before the American Society of Mechanical Engineers, New York, Dec. 4 to 7, 1922."

The following list of patents which embody the principles used in most modern underfeed stokers and are certainly of great interest as regards the history of stoker development, have been issued in France and America to Mr. Maurice Ratel:

France	No.	441,859	March	28,	1912
	No.	16,176	July	5,	1912
	No.	462,543	Sept.	15,	1913
	No.	470,231	March	30,	1914
	No.	511,360	Aug.	28,	1919
United States	No.	1,366,098	Jan.	18,	1921
	No.	1,389,982	Sept.	6,	1921
	No.	15,462	Sept.	26,	1922

Mr. Ratel's patents, although well-known in this country, have apparently been overlooked by Mr. Blackburn.

L. P. L. BATTU.

New York City.

What Is the Best Method of Erecting a Steel Stack?

In replying to the request of Thomas J. Rabbitt in the Dec. 19, 1922, issue, for information as to the best method of erecting a 3½x65-ft. steel stack, I would suggest the following if the local conditions are suitable:

First, obtain a gin pole between 40 and 50 ft. long and about 6 in. through at the top; erect this close to the base of the stack and secure it by four guys fastened at the top. Now place the lower end of the stack close to the gin pole and fasten on the main guy wires at the proper point, also attach the sling about one-third the length of stack from the top. The hitch on the pole must be high enough so that the tackle blocks will not come together when raising the stack. While the stack is being raised, it can be guided by temporary guys.

When the stack is vertical, make a lower hitch on it, so it can be raised high enough to place on the foundation. It will depend on the building whether or not more than one set of guy wires are necessary. With a 60-ft. stack on a good foundation three guy wires from one band will be sufficient; this would be placed one-third the length of the stack from the top.

Boston, Mass. F. C. EASTON.

A stack of the dimensions given by Thomas J. Rabbitt could best be erected in one piece—hoisted in place by using a good set of falls and a 50-ft. gin pole properly guyed.

If this equipment is not at hand and if the adjacent premises are not suitable to handle and hoist a 65-ft. stack, a convenient method is to make a four-legged scaffold about seven feet square; each leg made of two 2x4-in. scantling with joints overlapping, and 2x6-in. cross-tees and 2x4-in. bracing. This scaffold is erected ten or twelve feet ahead of the stack, with the hoisting tackle suspended on a convenient tie on top of the scaffold. The riveters work on the scaffold while the bucker-up stands on a platform disk made to fit inside of stack and suspended by ropes with hooks over the upper edge. One set of four guy lines is sufficient and should be placed at an elevation about 65 per cent of the total height, or in this case 43 ft. from the base of stack.

There are several improved methods of building steel stacks without a scaffold, but the size of this stack does not warrant the elaborate equipment necessary, while the material used in the scaffold can be used for other purposes later and there is practically no waste.

O. LANGELEY.

Some Important Factors Neglected

Under the title of "Some Important Factors Neglected," in the Jan. 2 issue, E. H. Peabody discussed my former communication of Nov. 7, 1922. In the second paragraph he states that furnace construction has not been as neglected as I stated owing to the high efficiencies obtained. Now, did you ever see in any publication, mention of plants or apparatus where the installation cost or even the operating cost was excessive? Did you ever see published data on small plants of from 1,000 to 2,000 kw. capacity with all operating details? Reflection will bring to mind that the plants of low cost and high efficiency are large ones, the average say of 20,000 kw. capacity and larger.

In the Middle West the average boiler plant has 20,000 sq.ft. heating surface or less. It is with these plants in mind that I wrote. During past years I have checked up the operations on such plants and find conditions on the average that are far below the figures found in publications. Since more coal is used in such plants than the total supplied to the larger stations, these conditions are serious, and nothing is to be gained by pointing with pride to the larger plants.

It is true that many such plants should be supplied by central-station service. However, where steam is needed for process or heating, it is more economical to build an efficient isolated plant. The automatic bleeder turbine steam plant can be made in units as low as 300 kw. capacity and shows a saving over central-station service, so it is my opinion that an industrial plant capable of using 500,000 kw.-hr. per year or more can best be served by an isolated plant where steam heating is involved.

Regarding the wide range mechanical burners mentioned by Mr. Peabody, I wish to state that I know the details of the construction, but in not excepting this burner in my former statement, I did so because it has not been thoroughly proved in the Middle West to my knowledge. I am glad to have had the burner called to my attention and would be glad to have others who have overcome the same difficulty, bring the information out in the light where we may learn all about them.

While we are on the subject, I should like to see published the operating details and construction costs for the smaller plants and information showing high costs as well as for the record plants that are referred to in publications. HUGH E. WEIGHTMAN.

Chicago, Ill.

Reliability of Single and Multiple Sources of Power for Manufacturing Plants

Referring to the article "Sources of Power for a Larger Industrial Plant," by R. A. Packard, an abstract of which appeared in *Power*, of Nov. 7, 1922, it seems to me that the problems confronting the designing engineer are the conditions under which a plant is to operate as well as the selection and arrangement of apparatus to meet these conditiions. Economy and reliability are the chief factors. Each is a problem in itself and should be worked out on its own merits.

In general the assurance of having power at all times is one of finances only. This question divides itself into two factors: first, the manufacturing cost; second, the cost of added power equipment to meet interruptions of service. The character and expense of the added power equipment depends somewhat on whether the load is a continuous one or whether it consists of a 10- or 12-hour daily load. Interruptions due to prime-mover troubles are rare and usually of such a nature that repairs can made at night. The average prime mover, boiler, and auxiliary are in general, properly designed and manufactured. Very few shutdowns occur ordinarily, in the industrial plant, and they are seldom for an extended period. In marine work vessels are rarely crippled owing to inability of the engines to operate. A prime mover is as reliable in an isolated plant as in a central station, and if the isolated plant contains several prime movers, the reliability should be very satisfactory. If a central station, say, carries 25 per cent reserve, there is no reason why the same proportion could not exist in an isolated plant. It is equally important to obtain high-grade skill and judgment in the design of an isolated plant as in a central station. If a plant is designed for an entire steam load, I should prefer splitting the units so that in case one should break down, the others could carry at least two-thirds of the load for a period long enough to cover the average repair work. There are a number of plants now using central power that could furnish their own power at probably less cost. This is especially true where there is use for byproduct heat.

A great deal depends on the personnel. If the prime movers are examined at frequent intervals, these interruptions are still lessened. No piece of machinery can be expected to operate successfully for a long period of time unless given proper care both in inspection and operation. If the number of shut-downs were analyzed a great many could ordinarily be avoided through proper care. Lower-grade men are more generally employed in isolated plants and in some cases work only part time in the power house; the equipment and reliability suffer as a consequence. The fault of reliability is not so much dependent on the material as on the personnel.

Where plants have a steam and hydro combination with steam sufficient to make up the stream-flow deficiency, the chances of power interruptions are minimized. In case of any steam interruptions under average conditions the water power can generally be drawn from for a sufficient length of time to effect repairs or vice versa. Where the stream flow is steady sufficient reserve should be on hand to carry at least two-thirds of the steam load.

Central-station plants are no more infallible to interruptions than the isolated plant. Where a number of central stations are tied together, it tends to increase the station reliability but not the transmission reliability. If line trouble is taken into consideration, central-station service gives perhaps more interruptions. The concern so tied up with this power is absolutely at the mercy of the central station, with no financial return for the interruption, which is generally so stipulated in the contract. In considering the purchase of power, reliability should be treated as a very important factor, and if there is any serious question on this point, the private plant would be a wise decision.

In general, there is no great need of multiple sources of power in the average plant. Multiple power in any case should be taken into consideration only where the financial loss in the manufacturing process is great and would more than offset the cost of additional means of obtaining power to cover the interruptions. I consider there is more trouble with the transmission of power than with the generation.

W. G. DIMAN, Supt. of Power,
Manchester, N. H. Amoskeag Manufacturing Co.

The well-arranged industrial power system described in R. A. Packard's paper, "Sources of Power for a Large Industrial Plant" shows a comprehensive treatment of a situation which often is not adequately considered in industrial plant design. Large industrial plants are subject to the operation of the laws of supply and demand, and consequently at times there may be a surplus or perhaps a shortage of power. Considering the period of normal operation, it is evident that continuity of service is essential for maximum production at minimum cost. Where operations are interrupted by power failure or shortage, the potential profit of production for that period is lost; an actual money loss is suffered by reason of material spoiled and in labor and overhead charges occurring during the delay.

In many instances even momentary interruptions are costly and cannot be overcome by multiple sources of power. Where bucket elevators are employed, the weight of the material will often reverse the elevator during a power interruption and dump the material in the "boot" of the elevator casing, which necessitates clearing the material from the elevator before starting up. Lengthy delays involving considerably more damage occur in mixers, agitators, autoclaves and where pumping apparatus handles liquids containing a percentage of solids. In such situations continuity of power must be secured at any cost, for otherwise tanks will have to be shoveled out by hand, and pipe lines dismantled and cleaned before the entire system becomes clogged with the product. Illustrations may be multiplied by the number of various industries, but the same result will probably obtain—a loss incomparable with the cost of additional sources of power.

The primary source of power is often operated in connection with the industrial plant and may be required by the need of high- or low-pressure steam, or both in processes. In a large factory two or more generating stations may be necessary in order to reduce the distance steam would have to be piped to reach process

units. As a certain reserve capacity is desirable in each station, these would supplement each other in cases of emergency. Let us survey the single central power plant: The reserve equipment must first be adequate for the operating routine; that is, the reserve capacity must be equal to or greater than the capacity of the largest unit, for every unit must be taken off the line regularly for minor adjustments and repairs. The provision for a serious breakdown after providing for operating routine reserve presents the criterion of the centralized power house. During the designing of the plant or when operations are smooth-running, the feeling is that the money represented by reserve equipment beyond that required by routine operations should be saved. If the product of the plant is at all valuable, which it must be to justify the investment, a serious power curtailment will cause a much greater loss than the constructive investment in reserve apparatus. The *element of probability* will most certainly assure a varying number of shutdowns over a period of years if a sufficient reserve is not provided over and above the

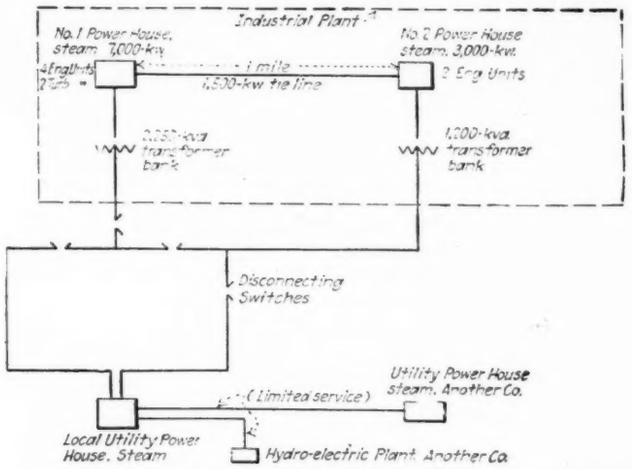


FIG. 1—MULTIPLE SOURCES OF POWER FOR A LARGE INDUSTRIAL PLANT

Two steam-power plants were preferred to a single plant on account of convenience in distributing steam for process heating. Reserve capacity in each station equaled that of the largest unit installed; emergency conditions utilized this reserve, making the outside source of power eventually necessary.

capacity of the largest unit. Sufficiency can be determined only by a study of the features of the individual situation. The elements that wreak havoc with the plant of limited reserve are: Cylinder reboring, crankpin breakage and bearing troubles in the reciprocating units; reblading, shaft straightening, thrust and sleeve bearing troubles with the turbine units; stator burnouts, shorted and grounded generator coils or rotating fields, which applies to all types of electrical units. These troubles are not from the prophetic vision or the "bogey man," but are a few of those experienced by the writer in a modern industrial plant over a period of six years, where four reciprocating and two turbine units were operated in the main power house and two reciprocating units in a second interconnected power house a mile away, with a total generating capacity of 10,000 kw. in eight units and a connected motor load of 2,500 hp., or 1,865 kw. (See Fig. 1).

In this instance the two power houses were separated by the requirements of process for live and exhaust steam at widely distant points. The power load was 5,000 kw. average 24 hours per day with a peak load not appreciably greater. The condition of reserve equal to the largest unit was fulfilled, with 3,000 kw. in No. 1 station and 1,500 kw. in No. 2 station. It is readily recognized that an interruption lasting a period of 30 days affecting the 3,000-kw. unit leaves practically one unit in seven as a spare.

To provide emergency service, connection was made to the local utility lines using a transformer bank of 2,250 kva. capacity in conjunction with the No. 1 station and bank of 1,200 kva. at the No. 2 station. The distribution system of each power house was an integral system, but the bus bars were connected with a tie line and interchange of energy was regularly made. The two "outside" transformers were supplied by two transmission lines which could be switched so as to provide an individual line to each transformer bank, or either line to supply both banks. The utility system was furnished power by two steam stations and one hydroelectric plant. However, even with the flexibility of the emergency source of power it suffered an interruption of 24 hours at one time due to a fire destroying the switchboard of the utility company's main steam station.

The emergency power source was not especially desirable and was used it spite of, and not because of the fact that it was a makeshift. The primary power was generated at 30 cycles and the emergency source was 25 cycles, the latter being utilized by providing certain distribution centers with double-throw switches, or in the case of the No. 2 power station the system was changed over by means of interlocked circuit breakers. Of course, production was slightly decreased by the lower motor speed resulting from lower frequency, but production did not cease altogether. It may be mentioned that a frequency changer set was not installed because of the emergency nature of the use of current and because the service of the utility company was not sufficiently reliable to justify the expense of a frequency changer; they too, were attempting to operate with insufficient reserve equipment. Fortunately, the utility companies in general are now able to overcome some of the financing difficulties and will thereby become a more potent factor in providing that essential feature of large industrial operations—continuity and adequacy of power supply.

J. ELMER HOUSLEY.

Kansas City, Mo.

Connecting Cylinder Drains of Compound Engines

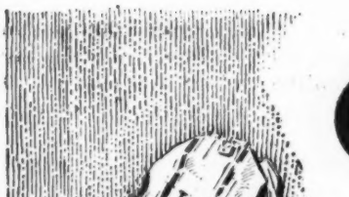
The method of connecting cylinder drains as advocated by Mr. Brodsky in the Nov. 28, 1922, issue, is decidedly an unusual and impractical one, and I certainly would expect trouble from water in the cylinder when operating an engine with the drains connected in this manner.

Under certain operating conditions and especially when stopping, the piston may produce a pumping action and draw water from the receiver into the cylinder. Similarly, if the engine were turning over slowly, as when turning up a commutator, steam would condense rapidly, and only the positive draining of the receiver would prevent water being carried over into the low-pressure cylinder.

In my opinion the proper way to connect the drains is to pipe each one separately and have the outlets above the high-water mark of the tank or heater into which they are connected. In addition to the drains every engine should be fitted with suitable relief valves on the cylinders.

O. PETTERSSON.

Winnipeg, Man., Canada.



QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Engine Horsepower for Given Electrical Output

What horsepower engine is required to drive a direct-connected generator with a capacity of 85 electrical horsepower? H. E. M.

The power required to be developed by the engine would depend on the efficiency of the engine and generator. For an output of 85 electrical horsepower by the generator, and the engine carrying a normal full load for its size, the mechanical efficiency of the engine would be about 88 per cent and the mechanical efficiency of the generator would be about 90 per cent. Hence the full load capacity required of the engine would be about $85 \div (0.90 \times 0.88) = 107.32$ indicated horsepower, or in round figures the engine should have a normal rating of about 110 hp.

Water Required for Ammonia Condenser

We have replaced an atmospheric ammonia condenser by a double type condenser. Can the amount of cooling water be reduced? I understand the amount of heat transferred per square foot is higher in the double pipe. R. G. H.

To cut down on the condensation surface, the final temperature of the water must be raised or the volume of water increased.

For example, assume that a condenser having 60 lin. ft. of 2-in. pipe per ton of refrigeration requires 2 gal. of water per minute per ton of refrigeration, with a final rise in temperature of 10 deg. F. Suppose, now, that this condenser was replaced with one of the later types having only 30 lin.ft. of 2-in. pipe per ton of refrigeration to do the same work. The same two gallons per minute per ton would be required on the condenser having 30 ft. as on the one having 60 ft. if the final temperature of 10 deg. F. is assumed in each case.

Gross Motor Capacity of Plant

We are considering the use of individual motors for driving our machines. A party figuring on the installation concludes that the combined capacity of all motors required would amount to 190 kw. This seems to be out of proportion, for at present the whole load is easily carried by our 150-hp. engine, and about one-third of the power developed by the engine is absorbed in engine and shafting friction. Is not the proposed gross motor capacity excessive? G. S.

The capacities of the motors should be sufficient for the most power ever required by the individual machines for which they are provided and these maximums should be determined by actual measurements. However, at any time when all machines are operated with less than their maximum requirement of power, the total power required will be less than the sum of motor capacities and thereby the highest number of horsepower required for the whole plant may never exceed a fraction of gross capacities of individual motors.

The nominal 150 hp. rating of the engine should not be taken as better than a very rough approximation of power required by the plant. The power actually developed should be determined by indicating the engine. To determine the probable gross output required of motors, take a large number of indicator diagrams from the engine at half-hourly intervals when the plant is in regular operation; then from the average deduct the average power shown by several indicator diagrams taken when the engine load consists only of engine and shafting friction.

Reducing Grate Surface of Heating Boiler

A cast-iron sectional boiler, used for heating an apartment house, is estimated to be twice as large as necessary for the purpose. Would it not be advantageous to build a bridge wall across the firebox so as to reduce the grate surface to about half the present area and cover the rear end of the grate with firebrick to form a combustion chamber? W. H. S.

Cast-iron sectional heating boilers generally are provided with grate surfaces of sufficient size to require stoking not oftener than two to four hours, when the boilers are operated to appropriate capacities. Consequently, boilers of this type usually are designed with a fewer number of square feet of heating surface per square foot of grate than customary for power boilers.

Shortening the grate as proposed would require more frequent firing and, with intelligent management, the extra attention thus required for operating the boiler should be compensated by somewhat greater economy of fuel, although not from development of the proposed combustion chamber, since the furnace gases would have much lower velocity than in power boilers, where a combustion chamber is beneficial in securing more perfect combustion by obtaining more thorough mixture of the furnace gases while at a high temperature.

Choice of Feed Water Temperature

We carry steam at 125 lb. pressure, using exhaust steam for heating feed water, also for heating stock in sulphite mill. If we carry feed water 200 deg. F., we have the live steam in stock 45 minutes out of 6 hours. If we carry feed water at 150 deg. we have live steam in the stock 30 minutes out of 6 hours. Which is more economical? J. E. G.

If, when heating stock with exhaust steam and carrying feed water at 200 deg. F., you then must replace the exhaust with live steam for 45 minutes out of 6 hours, this goes to show that by such use of exhaust it takes the place of live steam 7/8 of the time. In the

same way, if live steam is required 30 minutes out of 6 hours, when the boiler feed-water temperature is 150 deg. F., that would go to show that exhaust takes the place of live steam 11/12 of the time. The saving in live steam with the 150 deg. feed condition would be the difference between 1/8 and 1/12, or 4.5 per cent of as much live steam as would be required for operation of the stock heating exclusively with live steam. If the quantity of live steam required to operate the heating of stock is, say, 75 per cent of your boiler capacity, then the saving in live steam to heat the stock would be 4.5 per cent of 75 per cent or about 3.4 per cent of total boiler plant cost of fuel.

On the other hand, assuming that the boiler plant is operated at 125 lb. gage pressure, then lowering the temperature of the feed water from 200 to 150 deg. F. would represent an expenditure of 5.3 per cent more fuel. Therefore, if continuous live steam requirement for stock heating were 75 per cent of the total boiler output, there would be a loss of 5.3 — 3.4 = 1.9, or practically 2 per cent, to change from the conditions with feed water at 200 deg. F. to feed water at 150 deg. F.

If the stock, when heated by live steam alone, would require 25 per cent instead of 75 per cent of total boiler output, then from the use of feed water at 150 in place of 200 deg. F., the increase of fuel consumption for the whole boiler plant would be 25/75 of 2 per cent, or about 2/3 of 1 per cent.

Reaction-Type Turbines

What is meant by "reaction" and how is "reaction" applied to a commercial reaction type turbine?

G. F. W.

When a gun is discharged, the "kick" produced represents reaction. A skyrocket is another example of true reaction in which gas generated at high pressure next to the powder expands, so that the pressure pushes the rocket ahead.

A pinwheel is a true reaction turbine, driven by the pressure of expanding gas. A disk mounted on a hollow shaft, through which steam can be supplied and which would discharge through nozzles at the circumference of the disk, in the same manner as the gas expands in a pinwheel, would be a true reaction steam turbine. This type has been used commercially, but is not now manufactured on account of the high speed required.

In a pure reaction turbine expansion takes place only within moving parts and not in stationary nozzles or blades, as contrasted with an impulse turbine where expansion takes place in stationary nozzles only.

In order to use the most energy available, a moving skyrocket or turbine blade should discharge the gas or steam so that it stands still with respect to stationary objects. A ball dropped from a train will roll violently in the direction the train is running. If it is thrown toward the rear, with the same speed as the train, it will have no tendency to roll ahead or backward. A true reaction turbine at greatest efficiency should discharge steam at a speed equal to that of the blade, so that the steam discharged will not tend to travel forward or backward, in respect to stationary objects.

An impulse turbine must also discharge steam under the same conditions at greatest efficiency. A moving blade receives steam at discharge speed plus blade speed, since the blade speed is lost due to the impact or recoil of the steam.

For greatest efficiency an impulse turbine blade travels at half the speed of steam supplied and a true reaction blade at speed equal to that of steam expanded by it. Blade speed is limited by strength of materials, but steam speed is limited by nozzle conditions, which make economical velocities much higher than possible blade speeds.

Expansion does not take place in stationary parts of a true reaction-type turbine.

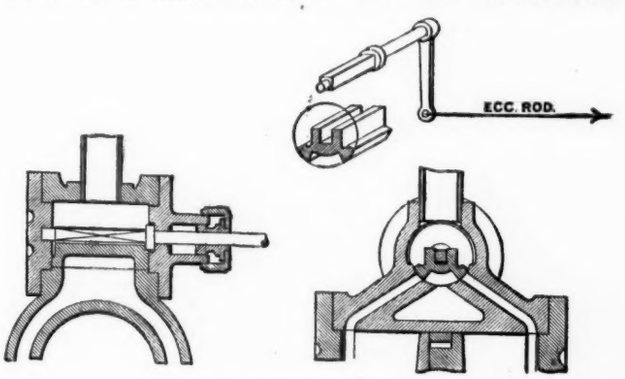
The commercially so-called reaction turbines are not pure reaction turbines, as steam also expands in the stationary blades. The velocity or speed thus gained, together with the velocity resulting from expansion in the moving blade, is used up in the moving blade by impelling it. These machines are really a combined impulse with reaction type, although usually spoken of as "reaction" turbines.

Operation of Rocking Valve

How is a rocking valve arranged to obtain distribution of steam and exhaust the same as by a D slide valve?

R. D. N.

An oblique view of a rocking valve and spindle are shown separately in the upper portion of the illustration. As indicated by the circle, the face of the valve in place of being flat, like an ordinary D valve, is turned off to match the bore of the valve seat as shown



ROCKING VALVE

in the part-longitudinal sectional view of the engine cylinder. A squared part of the spindle engages the valve along a slot in the back of the valve, and angular oscillation back and forth about the axis of the valve spindle is imparted to an arm connected with the eccentric rod instead of linear motion in the direction of the valve spindle, as in case of a slide valve. Steam supplied on top of the valve is thus distributed the same as by a flat seated slide valve and with sufficient depth of the slot that receives the squared spindle, the valve is free to find its seat under the action of the steam pressure, or may be raised off its seat by water that may be forced back from the cylinder of the engine. The double or "D" form of rocking valve is rarely used except on small engines. The usual practice is to provide a separate steam and an exhaust valve for each end of the cylinder, with each rocking valve in control of a single steam passage connected with the cylinder, as employed on Corliss engines.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Vapor-Refrigerating Condensers for Steam Turbines

Two methods of increasing the efficiency of the theoretical cycle upon which a steam turbine operates have long been recognized. One is to increase the initial pressure or superheat, and the other is to cut down the exhaust pressure. It is also well known that as the absolute exhaust pressure is reduced, each successive inch (of mercury) or each successive tenth of an inch reduction means a bigger and bigger gain in efficiency. With this in mind some engineers have speculated on the feasibility of increasing turbine efficiency by refrigerating the exhaust vapor, thus producing final temperatures and pressures much lower than any now obtainable. That any attempts along this line are doomed to commercial failure is the conclusion of F. C. Evans, instructor in heat power engineering at Cornell University, in an analysis of the problem in the December, 1922, issue of the *Sibley Journal of Engineering*, a publication of the Cornell engineering students. The following is an outline of some of the main points brought out by Mr. Evans:

At the present time the back pressure of the steam turbine is limited to around 1 in. of mercury absolute, corresponding to an exhaust-steam temperature of about 79 deg. F. It would require over 60 lb. of condensing water at 60 deg. F. to condense one pound of exhaust steam at this pressure. In localities where plants are fortunate enough to have condensing water available throughout the year at an average temperature lower than 60 deg. F., it is more economical to reduce the size of the condenser, than to reduce the back pressure.

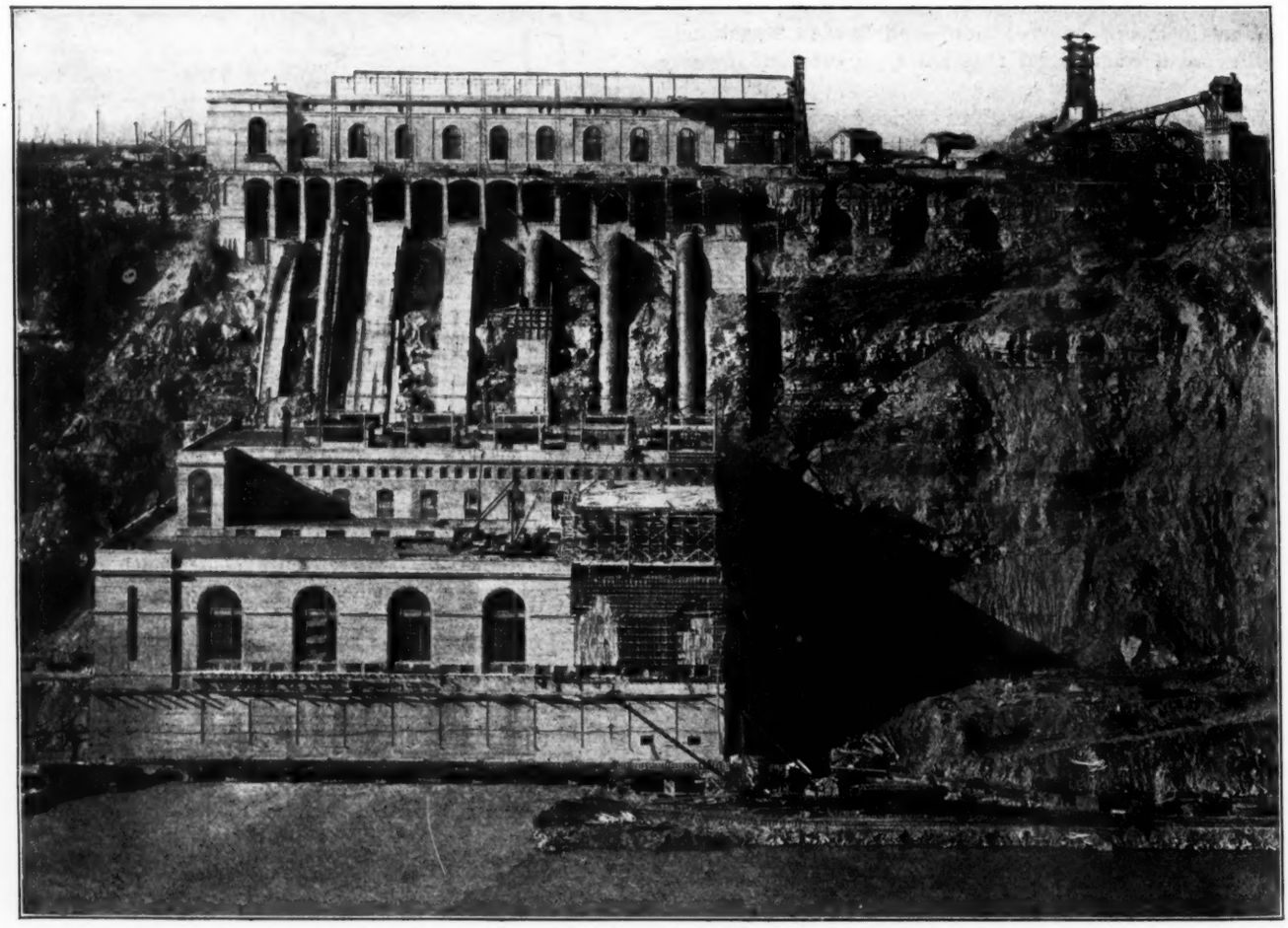
Refrigeration of the vapor to produce a lower vacuum corresponding to, say, 35 deg. F. would produce a considerable gain in the power available from the turbine. Supposing, however, that this refrigeration is produced by ammonia used on the wet-compression cycle, it is found that the extra power required to operate the refrigerating apparatus is more than the gain in the turbine. Thus, from the energy viewpoint alone, the vapor-refrigerating condenser cannot justify itself. The same is found to be the case if the refrigeration is produced by a dry-compression ammonia system, or if any other refrigerating vapor is used.

In addition there would be the extra investment for the refrigerating apparatus and practically no saving in first cost of the steam condenser. The latter, although handling a smaller weight of condensing medium per pound of steam, would have to handle steam of a much greater specific volume, with the result that practically the same size of condenser would be required. Moreover, a steam turbine designed to handle the enormous volumes of steam passing through the low-pressure stages would be much more expensive.

The estimated cumulative production of bituminous coal during 1922 to Dec. 23 stood at 397,631,000 tons according to the United States Geological Survey report for Dec. 30. Production during the first 301 working days of the last six years was as follows:

1917	530,535,000	1920	543,199,000
1918	571,530,000	1921	399,111,000
1919	446,650,000	1922	397,631,000

Thus it is seen that from the viewpoint of bituminous-coal production 1922 is 0.4 per cent behind 1921, 26.8 per cent behind 1920, 11.0 per cent behind 1919, 30.4 per cent behind 1918, and 25.0 per cent behind 1917.



FIRST SECTION OF QUEENSTON PLANT (ONTARIO HYDRO-ELECTRIC POWER COMMISSION) NEARING COMPLETION

Of 600,000 hp. ultimate capacity, present installation includes five 55,000-hp. vertical-shaft turbines operating under 305 ft. head. Penstock on extreme left is the ice-chute; the next is for the two waterwheel-driven exciters, and the five remaining penstocks—16 ft. in diameter at top and 14 ft. at bottom—are for the main units.

News in the Field of Power

Defends Muscle Shoals Offer

Kearns' Attack on Ford Plan Is Answered in House—Claim Ford Would Use 100,000 Hp.

A VIGOROUS answer to the attack by Representative Kearns, of Ohio, on the Ford offer for Muscle Shoals was made on Dec. 29 by Representative J. C. McKenzie, of Illinois, acting chairman of the House Committee of Military Affairs. In discussing the various provisions of the Ford tender, Mr. McKenzie dwelt on Mr. Ford's offer to do business on a net 8 per cent profit; the fact that he guarantees to manufacture a given amount of fertilizer; the necessity for the 100-year lease period; the adequacy of Mr. Ford's method of payment; what cheaper fertilizer means to the farmers, and how they will obtain it under the Ford plan. He urged the House to give the bill early and favorable consideration and stated that in his judgment the country will awaken to the fact that the farmers have not been deceived, but have been denied the one thing above all others that they hoped for at the hands of Congress.

In reply to the charge that Henry Ford does not agree to manufacture fertilizer, Mr. McKenzie quoted Colonel Hull of the Judge Advocate General's office, who told the Committee of Military Affairs that the bill as now drafted requires that Mr. Ford manufacture 40,000 tons of fixed nitrogen annually.

How Ford Will Use Power

In answer to another criticism, often repeated, that Ford agrees to use but one-tenth of the power development at Muscle Shoals for the manufacture of fertilizer, Mr. McKenzie declared that to produce 40,000 tons of fixed nitrogen a year, Ford would have to use more than 100,000 hp. That Ford would use nine-tenths of the Muscle Shoals power in the manufacture of products that would yield the greatest profit to himself was declared by Mr. McKenzie to be an unwarranted assumption, in view of the restraint of existing federal and state laws upon the manufacturers of such products.

In view of the obligations assumed by Ford in his offer, Mr. McKenzie declared that a lease of 100 rather than fifty years was not only fair but a necessity. The continued maintenance of nitrate plant No. 2 in readiness for the production of nitrogen to be used in the manufacture of explosives in time of war; the continued operation of nitrate plant No. 2 at full capacity for the production of the elements of commercial fertilizer in peace times; the payment of 4 per cent annually on the cost of the completion of dam No. 2, on the construction of dam No. 3 and on the cost of the flowage rights for the lease period; and, finally, the establishment of a sinking fund, which accumulating during the lease period would amortize the government for its entire expenditure—all of these obligations, said Mr. McKenzie, make the 100-year lease necessary if any good is to be derived from the development.

Coal Commission May Place Blame for Strikes

IT IS significant that, while the Coal Commission does not claim authority to negotiate or arbitrate, it does have a specific duty to investigate the causes of strikes. In an appeal to coal operators and mine workers assembled at Chicago to set up the machinery for wage-scale negotiations, John Hays Hammond states that the Commission will not hesitate to fix the blame if the mines are shut down on April 1. Were an impartial body like the Coal Commission to place the blame, all admit the possibility that the public may then take into its own hands the matter of arbitrating the disputed points, without being invited by either side of the controversy. The coal-consuming public is tired of living under the existing armistice between operators and mine workers. Peace, not an armed truce, is wanted. The people who burn coal look to the men who own the mines and to the men who work in them to come to terms and to keep at work.

Issues Report on Ventilation

A preliminary abstract of the report of the New York State Commission on Ventilation, outlining the work and giving the principal conclusions, has been issued by the Foreign Press Service, 215 West 33d St., New York City. The report, to be published on Jan. 1 by E. P. Dutton & Co., embodies the results of a series of experiments, begun in 1913, to study the physiological and mechanical phases of the ventilation problems. The final conclusion of the Commission is that the avoidance of overheating is the primary essential of all systems of ventilation and that the most important article of ventilation equipment is the thermometer.

The development of the power possibilities of the Pigeon and Rainy Rivers, boundary streams between Minnesota and Canada, is being considered. The Pigeon River Lumber Co. has applied to the Federal Power Commission for the privilege of developing five sites on that stream.

Start Quebec Hydro Project

To Develop 400,000 Hp. Initially on Lake St. John—1,200,000 Hp. Is Ultimately Planned

WORK has begun on the first power site of a water-power project to develop 1,200,000 hp. on Lake St. John and the Saguenay River in the Province of Quebec, Canada. The first development will be located at the outlet of the lake, where 400,000 hp. may be produced. Twelve generating units of 35,000 hp. each are contemplated. Eventually, it is stated, a second development 22 miles from the lake, where the river drops directly into tidewater, will provide 800,000 hp. more. The work already started at the first site includes the sinking of the cofferdams for the power-plant foundations, construction of the connecting railway over which materials will be hauled, and preliminary steps to raise the level of the lake 20 ft., to permit continuous flow to the turbines in the coldest weather.

American Engineer in Charge

The project is being undertaken by the recently formed Quebec Development Co., composed of United States and Canadian financiers. Heading the company is James B. Duke, president of the Southern Power Co. Associated with him as vice-president is Sir William Price, of Price Brothers & Co., Ltd., one of the largest print-paper manufacturing firms in the Dominion of Canada. The engineering side of the development has been placed in charge of W. S. Lee, chief engineer of the Southern Power Co., who has become a vice-president of the new company. The other vice-presidents are H. L. Brown and J. M. McCarthy, the latter a Canadian. The capital stock of $25,000,000 has been subscribed entirely by Mr. Duke and Sir William Price.

As a part of the plan it is announced that Price Brothers, Ltd., have entered into a contract with the new company for 200,000 hp. to be used in their paper mills. The site is less than 100 miles from Quebec, and the intervening country affords numerous opportunities for industrial plants.

A skeleton organization of the federal fuel distribution system is being maintained, pending the day when all possibility of a fuel emergency shall have been removed. F. R. Wadleigh has been designated by the President to succeed Conrad E. Spens as federal fuel distributor. Mr. Wadleigh has been chief lieutenant to Mr. Spens throughout the latter's administration. He also is continuing to fill the position of chief of the coal commodity division of the Department of Commerce.

The Engineer Must Lead, Say Scientists

Discuss Water Power, Conservation of Resources and the Relation of Engineering to Modern Life at Science Society's Meeting

"THE place of the engineer," an oft-recurring topic nowadays, was again brought into the limelight at the engineering and economic sessions of the Boston meeting of the American Association for the Advancement of Science, during the week of Dec. 26-30. Several noted engineers and educators agreed that the next step in engineering is to relate the problems of material advance in civilization to the human problems, and that the engineer may lead in solving these human problems if he will apply the logic of his thinking, fully understanding, however, that human problems involve emotion as well as logic.

That from the dawn of history emphasis has been placed upon the man who produces, was asserted by Dr. Ira N. Hollis, president of Worcester Polytechnic Institute. Dr. Hollis pointed out that the root words for "producer" in several of the earlier languages are synonymous with our definition of the term "engineer." One phase or another of engineering activity enters into practically all the arts and sciences. Dr. Hollis instanced the factors of transportation and communication as vitally touching life and the activities of men in all walks of life, and pointed out the engineer's place in the further development of transportation and communication systems. Both Dr. Hollis and Harrington Emerson, another speaker at the engineering session, pointed out the need of the engineer's analytical study of facts for the solution of present-day problems.

Lively Water-Power Discussion

The keynote of the joint sessions of the engineering and social- and economic-science sections was the relation of the engineer to conservation. John T. Black, state health commissioner of Connecticut, told of good work performed in reducing industrial waste. O. C. Merrill, executive secretary of the Federal Water Power Commission, arrived too late to present his paper on "The Federal Water-Power Policy and Its Results," but at the suggestion of Col. Henry S. Graves, of the Yale Forest School, who presided, a considerable discussion of the present water-power situation was evoked. Mention was made of the attack upon the water-power act by the State of New York, which resents the interference of the federal government in intra-state water-power administration as an infraction of state rights. The movement to lease Muscle Shoals to Henry Ford was also considered an attack upon the act, infringing as it does the provisions as to terms of lease and recapture.

On Friday evening Calvin W. Rice, secretary of the A.S.M.E., presented an illustrated address on "Engineering and Scientific Developments in South America." Mr. Rice said that there is much for North America to learn from the southern continent, and he used as one illustration the fact that the front pages of South American newspapers are devoted to world news and not to crime, such as fills many columns in even our leading dailies. He said also that while South America seems a new country to the North American, in reality there are civilizations in South America dating back to the beginning of the Christian era, the point being that if we are to contribute to the development of South America we must, as individuals, understand the spirit, temperament and historic background of the individual countries.

How North and South American Engineers May Join Forces

Mr. Rice pointed out three definite opportunities for an immediate association of North and South American engineers: First, the development of a common understanding of standards, the start of which was made definitely at the recent International Engineering Congress held at Rio de Janeiro; second, the development of an English-Spanish dictionary and glossary of engineering terminology; third, the development of an interchange of thought between the engineering societies of North and South America. In this connection Mr. Rice mentioned the appointment of Verne L. Havens, editor of *Ingeniería Internacional*, as permanent secretary of the International Engineering Congress, and he also recounted the personal contacts already established in the various government and engineering societies to bring about this more intimate engineering understanding between the two continents.

At the meeting of the engineering section on Friday afternoon, presided over by F. M. Feiker, vice-president and chairman of the section and vice-president of the McGraw-Hill Co., Inc., the address of the retiring vice-president J. B. Tyrrell, was on "The Growth of the Mining Industry in Canada."

A paper by Prof. C. F. Scott, of Yale University, president of the Society for the Promotion of Engineering Education, on "New Phases of Engineering Education," was presented in Dr. Scott's absence by Prof. Dugald C. Jackson, of Massachusetts Institute of Technology.

Ford Adds Three Gas Producers at Highland Park

The Ford Motor Co. is increasing the capacity of its producer-gas plant at Highland Park from 45,000,000 to 60,000,000 cu.ft. of gas per day, by the addition of three 16-ft. mechanically operated clean-gas producers.

Producer gas has thoroughly demonstrated its efficiency and dependability at the Highland Park plant. This gas is used for the development of power and for a great many industrial heating operations such as forging, heat-treating, tempering, brazing, soldering and others common to the automobile industry. The new producers are being built by the Smith Gas Engineering Co., Dayton, Ohio.

Retirement of Secretary Fall May Affect Girand Project

Since it is now certain that Secretary Fall will retire from the Cabinet on March 4, those interested in the Girand development at Diamond Creek, on the Colorado River, are in hope that the new Secretary of the Interior will take a different stand on the proposition.

Secretary Fall wants the government to construct all power developments on the Colorado River. The Secretaries of Labor and of Agriculture who, together with the Secretary of the Interior, constitute the Federal Power Commission, are understood to favor the Girand project, so that the Arizona copper companies and other interests may have as soon as possible the power they so greatly need. It is believed that the Girand license would have been authorized had it not been for Secretary Fall's ability to block it.

The water-power act provides, however, that no license shall be granted for a project affecting any reservation of the United States, unless the secretary having administrative control of that reservation sanctions the plan. In this case the Hualpai Indian reservation follows the south bank of the Colorado in the Diamond Creek area. This gives the Secretary of the Interior the legal power to block the project single-handed.

Seek to Hold Federal Engineers in Government Employ

Changes in title and in relative pay for professional employees of the Federal Government have been suggested because these men, especially technical experts, are leaving the service in increasing numbers. A bill to reclassify such Government employees and to readjust salaries was passed some time ago by the House, but although several hearings have been held by a subcommittee of the Senate appropriations committee, the final report on the bill has not been presented and fear is expressed that the measure will not be passed at the present session of Congress.

The civil service committee of the Senate considered this measure for several weeks and reported it, with a recommendation that it be passed, on Feb. 8, 1922. Because of the financial features of the bill, it was referred to the appropriations committee for further study. The civil service committee made a number of changes from the form in which the bill was originally passed by the House. It is said that the appropriations committee has been considering further reduction in the number of classes outlined in the bill,

and that there has been serious thought of eliminating workers in the field and confining the measure to Government employees within the District of Columbia.

Power Companies Install Carrier Current 'Phone System

Operating tests of a carrier current telephone system of communication were held recently in Baltimore by the Pennsylvania Water and Power Co., which has installed the system on its forty-mile, seventy-thousand volt, three-phase transmission line between the Holtwood (Pa.) hydro-electric generating station and a sub-station in Baltimore. Communication under varying conditions was effected in both directions. The Pennsylvania Water and Power Co. is among the first three companies to adopt carrier current for regular commercial operations. The system was installed first by the Utica Gas and Electric Co., Utica, N. Y. and it has also been tried recently by the Hartford Electric Light Co.

Society Affairs

New Haven Section, A.S.M.E., will consider "Fuels for Industry," on Jan. 15.

Franklin Union, Boston, Mass., will hear a lecture on "Petroleum Heat and Power," on Jan. 9 at Berkley and Appleton Streets, Boston.

San Francisco Section, A.S.M.E. will meet Jan. 11 at the Engineers' Club. H. W. Crozier will tell about his trip to the annual meeting.

Birmingham Section, A.S.M.E., will meet Jan. 18 at the Southern Club. A government film, "Compressed Air in Industry," will be shown.

Hartford Section, A.S.M.E., will hear R. R. Nelson, of the Tide Water Oil Co., on "Processing of Developing Oil," at its meeting on Jan. 15 at Jewel Hall, Y.M.C.A.

Boston Section, A.S.M.E., will meet Jan. 11 at the Affiliated Technical Societies' rooms. J. R. McDermet, chief research engineer of the Elliott Co., will speak on "Control of Boiler Corrosion."

Cornell Society of Engineers will hold its seventeenth annual dinner and reunion on Jan. 19 at the Fifth Ave. Restaurant, 200 Fifth Ave., New York City. President Livingston Farrand and Dean Dexter S. Kimball will speak.

New Publications

Hendricks' Commercial Register. Published by S. E. Hendricks Co., Inc., 70 Fifth Ave., New York City. Cloth, 8 x 12 in.; 2,321 pages. Price, $15 (including Hendricks' Commercial Bulletin, the monthly supplement, and complete service.)

The thirty-first annual edition (1923) of this comprehensive commercial register of the United States for buyers and sellers.

Engine-room Chemistry. By Augustus H. Gill, Professor of Technical Analysis, Massachusetts Institute of Technology. Third Edition. Published by McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York City, 1922. Cloth; 5½x8 in.; 174 pages; 49 illustrations and 19 tables. Price, $2.

This third edition brings up to date a book that has long served to instruct operating engineers in the principles of chemistry and their applications in the power plant. No previous knowledge of chemistry is required. The book starts with the first principles and works up by easy steps to such practical applications as flue-gas analysis, fuel analysis, feed-water analysis and treatment, the chemistry of combustion and the selection of oils for various purposes. Among the changes made from the second edition is the introduction of a description of the Cleveland oil tester and the enlargement of the chapter on combustion.

Fusability of Ash from Coals of the United States. By W. A. Selvig and A. C. Fieldner. Bulletin No. 209 of the Bureau of Mines, Department of the Interior, Washington, D. C.

The results of a series of laboratory tests to determine the "fusing" or "softening" temperatures of the ash from coals of the United States. The information made available through this publication is of value to all consumers of coal, because of its relation to the troublesome clinker problem. A series of tables gives the softening temperatures of coal ash from every productive field in the country. A complete index enables the consumer to find quickly the table for the particular kind of coal he is using.

Test of Drainage Pumping Plants in the Southern States. By W. B. Gregory, irrigation engineer. Bulletin No. 1067 of the United States Department of Agriculture. Price, 10c.

This professional paper describes the pumps used in drainage pumping plants in the southern states, mentions briefly the pipe losses at suction and discharge, lists the sources of power for pumping plants and gives the results of tests and costs of operation.

Transformer Standards. Handbook published by the transformer section of the Electric Power Club, Kirby Building, Cleveland, Ohio. It may be obtained from any American manufacturer of distribution or power transformers.

This second edition contains information on all transformer standardization effected to date by the Electric Power Club. The different sections of the club are actively engaged in establishing standards for electrical apparatus, and information on additional standards established by these sections will be published as they are adopted.

Manual of Smoke and Boiler Ordinances and Requirements. Official publication of the Smoke Prevention Association, 111 North Dearborn St., Chicago, Ill. 1922 edition. Paper, 6 x 9 in.; 124 pages.

This résumé of the smoke prevention situation in America contains the complete proceedings of the 1922 meeting of the Smoke Prevention Association at Cleveland the report of the standardization committee on smoke prevention; an article entitled "What's at the Bottom of the Smoking Stack?" and a complete list of cities having boiler ordinances as well as laws for the abatement of the smoke nuisance, with full reproduction of those ordinances.

Commercial Travelers' Guide to Latin America. Published by the Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C. Second edition; 698 pages, 40 maps. Price, $1.25.

This new edition of the commercial encyclopedia of the countries south of the United States is almost a new work, representing a complete rearrangement of data, the addition of an enormous quantity of new details and a considerable improvement in the quality of most of the sections. It has been well termed the commercial Baedeker of Latin America.

Manufacture and Use of Commercially Pure Iron in Gas and Electric Welding. Reprint of an article by C. A. McCune in the "Journal of the American Welding Society" for June, 1922. Copies may be obtained from the American Welding Society, 29 West 39th St., New York City.

In this paper, whose title is self-explanatory, the author concludes that a

Coming Conventions

Society of Automotive Engineers; 29 W. 39th St., New York City. Annual meeting at New York City, Jan. 9-12.

American Engineering Council; L. W. Wallace, secretary, 24 Jackson Place, Washington, D. C. Annual meeting at Washington, D. C., Jan. 11-12.

Compressed Gas Manufacturers' Association; John H. Hays, 120 W. 42d St., New York City. Annual meeting at New York City, Jan. 15.

Marine Engineers' Beneficial Association; George A. Grubb, secretary, Machinists' Bldg., 9th St. and Mount Vernon Place, Washington, D. C. Annual meeting at Washington, Jan. 15-20.

American Society of Civil Engineers, 29 W. 39th St., New York City. Annual meeting at New York City, Jan. 17-18.

Iowa Engineering Society; Lloyd A. Canfield, secretary, 406 Flynn Bldg., Des Moines. Annual meeting at Des Moines, Jan. 23-26.

American Society of Heating and Ventilating Engineers, 29 West 39th St., New York City. Annual meeting: Jan. 23 at New York City, Jan. 24-26 at Washington, D. C.

American Boiler Manufacturers' Association; H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Winter meeting at New York City, Feb. 12.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Mid-winter convention at New York City, Feb. 14-16.

American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 19-21.

good welding metal should produce a weld approaching the general physical characteristics of the base metal; it should not contain or tend to create gases; it should be free from slag or slag-forming ingredients; it should be chemically and physically uniform, and it should be easy to use. The paper outlines and illustrates the steps in the manufacture of such a wire.

Diesel Engines for Land and Marine Work. 5th Edition. By A. P. Chalkley. Published by D. Van Nostrand Company, New York and London, 1922. Cloth; 6x9 in.; 326 pages; 171 Illustrations. Price, $6.

For years the only treatise on the Diesel engine in the English language was Chalkley's. Each new edition was revised to incorporate the latest developments in Diesel engine design.

The fifth edition of this work, just off the press, covers the most important portion of the earlier edition as well as the advancements made since the World War. The engines described are strictly European, and the American reader will regret that Mr. Chalkley has seen fit to ignore the progress in the United States. In view of the fact that the United States stands next to Germany in the horsepower of Diesels installed, the design of which engines are by no means the same as European designs, it is surprising that the author has failed to mention a single American Diesel engine. Likewise his brief discussion of the solid-injection engine leaves much to be desired, especially since there are many European as well as English builders engaged in the manufacture of this design of machine.

The trend of oil-engine development is toward the marine type and the author takes considerable space in discussing the advantages of motor ships, operating data and procedure, etc.

The subjects covered are, General Theory of Heat Engine; Action of Diesel Engine; Construction; Installing of Diesel Engine; Testing; Marine Diesel; Construction of Marine Diesel; Design; Future of the Diesel Engine.

The volume is well written and finely illustrated with drawings of modern engines. Mr. Chalkley's work is one which no engineer should fail to include in his five-foot bookshelf.

Personal Mention

Prof. Robert C. H. Heck, of Rutgers College, has been awarded life membership in the A.S.M.E. for a paper on "Steam Formulas."

George M. Shepard, formerly associated with L. P. Wolff, of St. Paul, Minn., has been appointed chief engineer of the Department of Public Works of that city.

J. E. Yorkston has been promoted from the position of engineer in charge of the drafting department to consulting mechanical engineer for the General Electric Co. He has been with the company since 1894.

Frederick A. Scheffler, manager of power department, Fuller Engineering Co., Fullerton, Pa., gave a popular talk by radio on Dec. 21 at the Westinghouse broadcasting station, Newark, N. J., on the subject of powdered coal as a fuel.

John Anderson, chief engineer of the Milwaukee Electric Railway and Light Co., and designer of the Lakeside station, is a member of the Safety Commission of Milwaukee—a good example of the engineer in the service of the public.

O. D. Street, formerly general manager of distribution of the Western Electric Co., has organized a company of consulting specialists to deal with questions affecting management and distribution. Mr. Street severs a twenty-two-year connection with the Western Electric Co. For the last ten years he was in charge of the company's distributing operations.

Norris R. Sibley, formerly with the Westinghouse company, has joined the London Steam Turbine Co. as manager of the New York district, with jurisdiction over all marine work on the Atlantic seaboard. **Franklin C. Vandervort, Jr.**, also with Westinghouse for the last four years has assumed managership of the London Steam Turbine Co's. Chicago office, with jurisdiction over all marine work on the Great Lakes.

Business Notes

The Detroit Seamless Steel Tubes Co. has appointed L. R. Phillips district sales manager, with headquarters in Chicago. For the last twenty years Mr. Phillips has been associated with the National Tube Co., St. Louis, Mo.

Elliott Company, Pittsburgh, Pa., has opened a new district sales and service office in Baltimore, at 1514 Lexington Building, in charge of J. R. Lemon, who has been transferred from the company's Philadelphia office.

The Union Iron Works, Erie, Pa., manufacturer of steam boilers, has appointed James G. Gordon as New York district manager, with offices at 50 Church St. Mr. Gordon was formerly with the Dravo-Doyle Co., Philadelphia, Pa.

The Smith Gas & Engine Co., Dayton, Ohio, has appointed the Vincent-Gilson Engineering Co., 30 Church St., New York City, as its eastern representative, and Harry Himmelblau, 179 West Washington St., Chicago, Ill., as its representative in the Chicago territory.

Manning, Maxwell & Moore, Inc., have appointed William P. Bradbury as sales manager of their brass goods plants — The Ashcroft Manufacturing Co., The Consolidated Safety Valve Co., The Hancock Inspirator Co., and The Hayden & Derby Manufacturing Co. Mr. Bradbury's headquarters will be at 119 West 40th St., New York City. He has been associated with Manning, Maxwell & Moore, Inc., for over twenty years. He was originally assistant to the late G. P. Brigham and finally worked into the selling end, where he has represented Manning, Maxwell & Moore, Inc., in Cuba, Mexico, the South and Southwest, and in the New York territory. He brings to his new position a wide knowledge of the brass goods line and has a large and valuable circle of friends.

The General Electric Co. has reorganized its general manufacturing department, effective Jan. 1. H. F. T. Erben, heretofore manager of the Schenectady works, has been appointed vice-chairman of the manufacturing committee. Charles E. Eveleth has been advanced to the managership of the Schenectady plant, while J. A. Smith will continue as general superintendent, and in the absence of Mr. Eveleth will be in charge of the works. The general manufacturing department, of which Vice-President G. E. Emmons is in charge, is as follows: H. F. T. Erben, vice-chairman of manufacturing committee and ranking member of the staff; J. T. Broderick, secretary of the manufacturing committee; L. G. Banker, general purchasing agent; M. C. Fitzgerald, manager of transportation department; W. C. Fish, manufacturing engineer; W. B. Curtiss, supervisor of production; G. S. Maxwell, supervisor of costs; and E. Z. Steezer, supervisor of industrial relations.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Dec. 18, 1922	Dec. 26, 1922
Pool 1,	New York	$5.50–6.00	$6.00–6.50
Smokeless,	Columbus	5.75–6.25	5.75–6.25
Clearfield,	Boston	3.50–4.85	3.75–4.75
Somerset,	Boston	3.75–4.50	4.00–4.85
Kanawha,	Columbus	2.90–3.10	3.00–3.25
Hocking,	Columbus	2.50–2.75	2.75–3.00
Pittsburgh No. 8	Cleveland	3.15–3.25	3.20–3.35
Franklin, Ill.,	Chicago	4.00–4.25	4.00–4.25
Central, Ill.,	Chicago	3.00–3.25	3.00–3.25
Ind. 4th Vein,	Chicago	3.75–4.00	3.75–4.00
West Ky.,	Louisville	2.00–2.50	3.25–3.50
Big Seam,	Birmingham	2.25–2.50	2.50–2.75
S. E. Ky.,	Louisville	3.00–3.75	3.25–3.75

FUEL OIL

New York—Jan. 4, Port Arthur light oil, 22@25 deg. Baumé, 4⅞c. per gal.; 30@35 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

Chicago—Dec. 16, for 24@26 deg. Baumé, 90c. per bbl.; 32@36 deg., 2¼@3c. per gal. in tank car, f.o.b. Oklahoma refinery, or freight adjusted.

Philadelphia—Jan. 2, 26@28 deg. Baumé, Oklahoma, 90@95c. per bbl.; 30@34 deg., Oklahoma (group 3), 2⅝@2¾c. per gal.; 16@20 deg. Seaboard, $1.30@$1.40 per bbl.

St. Louis—Dec. 26, f.o.b. Oklahoma 24@26 deg., 95c. per bbl.; 26@28 deg., $1 per bbl.; 28@30 deg., $1.05 per bbl.; Gas oil 32@36 deg., 2¾c. per gal.; 36@40 deg., distillate, 3¼@3½c. per gal.

Pittsburgh—Dec. 27, f.o.b., refinery, Penn., 36@40 deg., 5½@5¾c. per gal.; Kentucky, 26@30 deg., 4c.; Diesel, 3¼c.; Gas oil, 32@36 deg., 2¼@2¾c.; 36@38 deg., 2½@3c.; 38@40 deg., 90c.@$1.05 per bbl.

Dallas—Dec. 30, 26@30 deg., $1.28 per bbl.

New Plant Construction

PROPOSED WORK

Calif., Bakersfield—The Bd. Supervisors of Kern County received bids for the construction of a group of hospital buildings, here, general contract, from W. G. Reed, 204 Brock Bldg., Long Beach, $427,000. K. E. Parker, 519 California St., San Francisco, $505,800; Currie & Dulgar, Kern County Land Bldg., $524,573; heating and ventilating, F. Davidson, Washington Bldg., Los Angeles, $29,440; Currie & Dulgar, $20,000; plumbing, heating and ventilating, Burnham Plumbing Co., 1220 Webster St., San Francisco, $63,976. Noted Nov. 21.

Calif., Hanford—The city plans to purchase pumps and motors for ejector pits.

Calif., Los Angeles—G. Woodruff, A. R. Walker, et al., c/o Walker & Eisen, Archts., Finance Bldg., is having plans prepared for the construction of a 13 story, office building on 8th St. Estimated cost $500,000. Equipment detail not reported.

Calif., Oakland—County of Alameda plans election to vote $2,000,000 bonds for a courthouse.

Calif., Oakland—Mills College, is preparing plans for the construction of a group of college buildings on 59th Ave. Estimated cost about $500,000. W. H. Ratcliff, Jr., First National Bank Bldg., Berkeley, Archts. Equipment detail not reported.

Calif., Orange—C. E. Short is in the market for refrigeration machinery and equipment.

Calif., Petaluma—The Petaluma Hotel Co., c/o Chamber of Commerce, F. Whitton, Constr. Mgr., 251 Kearny St., San Francisco, plans the construction of a 5 story, 100 room hotel. Estimated cost $250,000.

Calif., San Francisco — The National League for Woman's Service, c/o W. Polk & Co., Archts., Hobart Bldg., is having preliminary plans prepared for a 7 story club building to be known as "Women's City Club" on Post St. Estimated cost $1,000,000.

Calif., San Rafael—The National Ice Co., Postal Telegraph Bldg., San Francisco, is having plans prepared for the construction of a 2 story addition to ice plant on 4th St., here. Estimated cost $100,000. Private plans.

Calif., Scales—Peer & Berkey, c/o J. P. Sweeney, Nevada Bank Bldg., San Francisco, plans the construction of pipe line 4.51 mi. long, riv. steel 60 in.; 56,100 lin.ft. earth and rock canals; 2 diversion dams 100 ft. long 20 ft. high; several storage dams, power plants to develope 36,000 hp. using Impulse wheels direct connected to generators; fall of 1,330 ft. 250 sec.ft. through penstocks.

Calif., Stockton—The College of the Pacific, College Park, plans the construction of seven 2 story college buildings consisting of liberal arts, administration, auditorium buildings, conservatory of music, men's and women's dormitories, gymnasium, etc. Estimated cost $650,000. Davis-Heller-Pearce Co., Delta Bldg., Archts. and Engrs.

Conn., Bridgeport—The Bd. Educ., plans the construction of a 3 story, high school on Boston and Central Aves. Estimated cost $900,000. Caldwell, Walker & Beckwith, 886 Main St., Archts. W. B. Ittner, 911 Locust St., St. Louis, Mo., Assoc. Archt. Noted Sept. 26.

Fla., Zephyrhills—The city council will receive bids until Jan. 30 for waterworks improvements, including pumping station buildings, 2 centrifugal pumps and engines, 75,000 gal. tank, 110 ft. tower, 25 fire hydrants, and valves, 200 ton c.i. pipe, 10,000 ft. galv. pipe, also digging of well. Estimated cost $25,000. E. V. Camp, Moreland and DeKalb Aves., Atlanta, Ga., and associates, Engrs.

Ga., Rome—The Battey Machinery Co., West 2nd Ave., is in the market for air compressor, 2,000 ft. capacity, belt power driven or motor.

Ill., Chicago—St. Joseph's Convent, 575 Layton Blvd., Milwaukee, Wis., will soon receive bids for the construction of a 4 story, 220 x 236 ft. high school on Lawndale Ave. and Byron St. Estimated cost $500,000. Brust & Phillipp, 405 Bway., Milwaukee, Wis., Archts. Equipment detail not reported. Noted Oct. 31.

Ill., Wilmette—The Beach Manor Real Estate Improvement Co., c/o R. L. Simmons, Archt., Beardsley Blk., Elkhart, Ind., is receiving bids for the construction of a 9 story, 225 x 225 ft. apartment hotel, including private water system, high pressure boilers, etc. Estimated cost $1,500,000. Noted Sept. 5.

Ind., Auburn—The city, E. Weiland, Mgr., plans the construction of a 1 story addition to electric light plant. Estimated cost $60,000.

Ind., Crawfordsville—R. R. Donnelley & Sons, 731 Plymouth St., Chicago, Ill., is having revised plans prepared for the construction of a 3 story printing plant. Estimated cost $1,000,000. H. Shaw, 39 State St., Chicago, Ill., Archt.

Ind., Ft. Wayne—The Ft. Wayne Dairy Co., is having revised plans prepared for the construction of a 2 story, 60 x 100 ft. dairy, including high pressure steam heating system, conduit electric system, ammonia refrigeration plant, electric crane, vacuum pumps, etc., on Fairfield St. Estimated cost $50,000. McCormick Co., Century Bldg., Pittsburgh, Engr.

Ind., Indianapolis — The Meyer-Kiser Bank, 136 East Washington St., is receiving bids for the construction of an 11 story, 60 x 200 ft. bank and office building, including steam heating system. Estimated cost $1,000,000. Vonnegut, Bohn & Mueller, Indiana Trust Bldg., Archts.

Ind., Indianapolis—The Vonnegut Machinery Co., 19 West South St., is in the market for an electric motor and generator.

Ia., Oakland—The city plans waterworks improvements, including reservoir and auxiliary pump. Estimated cost $15,000.

Kan., Wichita—O. S. Shirk, 805 Schweiter Bldg., plans the construction of a 5 story, 100 x 140 ft. hotel on 42nd St. and Topeka Ave. Estimated cost $250,000. Eberson & Weaver, Orpheum Bldg., Archts. Noted Dec. 12.

Ky., Pikeville—The Cumberland Pub. Co., is in the market for a 110 a.c. motor, saw trimmer and other printing equipment.

La., Baton Rouge—The Louisiana State University, Bldg. Comn., R. L. Himes, Secy., will receive bids until Jan. 10, for the construction of 2 story civil and mechanical engineering building, estimated cost $225,000; residence for the Dean of the Agricultural Dept., $10,000; underground tunnels for steam pipes electric power and lighting wires, sewers and other facilities, distance of 30,000 ft., $30,000, for the State Agricultural College. T. Linck, Capitol Bldg., State Archt.

Mich., Jackson—The Michigan State Prison is having preliminary plans prepared for state prison at North Forum. Estimated cost $3,000,00. Smith, Hinchman & Grylls, 800 Marquette Bldg., Detroit, Archts. Noted Jan. 11, 1921.

Minn., Duluth—St. Luke's Hospital, 903 East 1st St., is having plans prepared for the construction of the superstructure for hospital, including steam heating system. Estimated cost $800,000. Schmidt, Garden & Martin, 104 South Michigan St., Chicago, Ill., Archts. German & Jensen, 411 Exchange Bldg., Assoc. Archts.

Minn., Duluth—The Occident Elevator Co., Bd. of Trade Bldg., will receive bids about Feb. 1 for the construction of a 6 story, 200 x 350 ft. grain elevator to be electrically operated, including steam heating system in part of building, on River front. Estimated cost $900,000. Architect and Engineer not selected.

Minn., Minneapolis — The city council, W. R. Young, City Registrar, approved plans for installation of pumping unit and filter plant, 40,000,000 gal. daily capacity. Estimated cost $2,673,360. Work will be done by day labor. N. W. Elsberg, City Engr. Noted Jan. 24, 1922.

Minn., Morris—The city voted a bond issue Dec. 5 for the construction of a 42 x 62 ft. pumping station, also furnishing and installing crane. C. F. Tweed, 531 Metropolitan Bank Bldg., Minneapolis, Engr. Bids called for Oct. 20 were not opened because of public protest. Noted Oct. 17.

Minn., St. Paul—The Orpheum Circuit, State Lake Bldg., Chicago, Ill., plans the construction of a theatre, here, including steam heating system. Estimated cost $1,000,000. Architect not announced.

Minn., St. Paul—The St. Paul Gas Light Co., 6th and Cedar Sts., is having plans prepared for the construction of a 100 x 225 ft. generating plant and a 60 x 150 ft. coal pulverizing shed for power plant, on Island in Mississippi River near Omaha Rd. Bridge. Toltz, King & Day, 1410 Pioneer Bldg., Engrs.

Minn., Westbrook—The village rejected bids opened Dec. 11, 1922, for waterworks improvements, including 11,375 ft. of 4 in. c.i. pipe, 14 hydrants, 11 gate valves, 4,200 lb. special castings, pump house and pumping unit. Contract for well awarded to McCarthy Well Co., 670 Eustis Ave., St. Paul, $6,800. Noted Dec. 7.

Mo., Lamar—The Lamar Water & Electric Plant will receive bids until Jan. 15, for furnishing additional power equipment, consisting of an engine or engines with d.c. generators for improvements to the city electric lighting system. J. M. Earp, Mayor and Chn. Utilities Com.

Nebr., Omaha — J. and A. McDonald, Archts., 204 Standard Oil Bldg., will receive bids until Jan. 26 for the construction of an 8 story, 132 x 132 ft. club and office building, including steam heating system, on 18th and Dodge Sts., for the B. P. O. E., c/o O. Nielson, Secy., Elks Bldg. Estimated cost $1,500,000. Noted Nov. 1, 1921.

N. M., Bernalillo—The White Pine Lumber Co., plans the construction of a lumber mill. Estimated cost $500,000. Architect not announced. Owner is in the market for complete machinery and equipment.

N. Y., Alden—Erie County Bd. Supervisors, City Hall, Buffalo, is in the market for refrigeration machinery and equipment for plant, here.

N. Y., Johnson City—The Binghamton Light, Heat & Power Co., 172 Washington St., Binghamton, plans to install new 10,000 kw. turbine and three 600 hp. boilers, together with auxiliary equipment, at its plant here, estimated costs $850,000; also plans the construction of a service line from Binghamton to Sayre, Pa. Estimated cost $225,000.

N. Y., New York—The Arctic Hygeia Ice Mfg. Co., 300 East 133d St., is having plans prepared for addition to ice plant. Estimated cost $500,000. Ophuls & Hill, 112 West 42d St., Engrs. Owner is in the market for ice making machinery for same.

N. Y., New York—The Bd. Educ., C. J. B. Snyder, Supt. Bldgs., Concord St. and Flatbush Ave., Bklyn., will receive bids until Jan. 11, for installing heating, ventilating and temperature apparatus, etc., in new P. S. 69, on Randall Ave., Boro of Bronx, in P. S. 80 on East 120th St. and in P. S. 139 on West 140th St., Boro of Manhattan.

N. Y., New York—The Dept. Water Supply, Gas & Electricity, 2351 Municipal Bldg., N. J. Hayes, Comr., rejected bids received Dec. 22, for furnishing, delivering, installing and connecting forged steel crossheads one each on the high, intermediate and low pressure cylinders of Davis & Farnum engines in the Ridgewood Northside Pumping Station, Atlantic Ave. and Logan St., Bklyn. Bids will be readvertised. Noted Dec. 19.

N. Y., New York—The Star Fuse Co., 168 Centre St., is in the market for two 20 kw. 125 volt d.c. generators, etc.

N. Y., New York—The Transit Comn., G. McAneny, Chn., 49 Lafayette St., will receive bids until Jan. 15, for the construction of transformer closets for emergency lighting for a part of the Broadway-Fourth Avenue Rapid Transit Railroad, Boro of Manhattan.

N. Y., Saratoga—The Saratoga Hospital, Church St., plans the construction of a new central power house. Estimated cost, $50,000. W. H. Vaughn, 400 Bway., Saratoga Springs, Engr. Owner is in the market for power house equipment.

Ohio, Cleveland—The Cleveland Protestant Orphan Asylum, c/o E. J. Henry, Supt., 5,000 St. Clair Ave., is having preliminary plans prepared for the construction of a 1 and 2 story orphanage, including steam heating system on Harper and South Kinsman Roads. Estimated cost $500,000. C. W. Hopkinson, 900 Rose Bldg., Archt.

Ohio, Cleveland—Dept. of Welfare, H. S. MacAyeal, Dir., 9th and Oak Sts., Columbus, will receive bids until Jan. 10 for equipment for 5 wells including pumps and piping at Deu Farm, State Hospital, here.

Ohio, Cleveland—H. C. Wolf, 626 Swetland Bldg., is in the market for complete refrigerating plant for market house.

Okla., Burbank—The City Clerk will receive bids until Jan. 15 for entire new waterworks and sewer system. Bonds for $88,000 were voted for same. J. M. Burkley, Pawhuska, Engr. Deep well pumping equipment will be installed.

Okla., Morris—The city, R. Ward, Mayor, voted Dec. 14, $67,000 bonds for the construction of a dam, filter plant, pumping machinery and 4 to 8 in. pipe lines. H. G. Olmsted & Co., 415 Oil Exchange Bldg., Oklahoma City, Engrs.

Pa., Allentown—S. Mellner, 233 North 8th St., plans the construction of a coal loading and handling station on Lehigh St. Estimated cost $20,000. Architect not announced. Owner is in the market for machinery and equipment.

Pa., Allentown—Swift & Co., plans the construction of a meat packing and cold storage plant on Lehigh St. Estimated cost $5,000. Architect not announced. Owner is in the market for machinery and equipment.

Pa., Easton—Binney & Smith Co., is having plans prepared for the construction of a 4 story, 80 x 100 ft. manufacturing plant and 250 hp. power plant. Lockwood-Greene Co., 101 Park Ave., New York, Engrs.

Pa., Johnstown—Cambria County Comrs., Court House, Ebensbury, is having plans prepared for the construction of 1 and 2 story, 40 x 230 ft., 35 x 80 ft. and 30 x 40 ft. buildings for a tubercular hospital, here. Estimated cost $250,000. W. R. Myton, 1204 1st Natl. Bk. Bldg., Archt. Equipment detail not reported.

Pa., Scranton—The Bd. of Pub. Wks., W. LaFontaine, Dir., is in the market for 1 electric motor (new). Estimated cost $1,000.

S. D., Aberdeen—The city plans waterworks improvements, including 500,000 gal. reservoir, 125 ft. elevated tank 200,000 gal. capacity, pump house, pumping equipment and 12 in. main on South Main St. Estimated cost $150,000. F. LeCocq, City Engr.

S. D., White Lake—The city will receive bids until Jan. 11 for waterworks system, including 12,510 ft. of 4 to 8 in. c.i. pipe; two 300 g.p.m. each centrifugal pumps, belt connected to engines with discharge pipe lines, or two 300 g.p.m. triplex plunger pump belt; one 50 g.p.m. deep well plunger pump, belt connected to gas engine with drop and discharge pipe, or 1 air lift well pump with compressor belt; 50,000 gal. elevated tank on 100 ft. tower with riser pump; pumping station and 100,000 gal. reservoir. Estimated cost $30,000. Smith & Reeves, Mitchell, Engrs.

S. D. Yankton—The city plans an artesian well including pump, connection, etc. Estimated cost, $15,000.

Tex., Dallas—A. W. Childress, 1714 Prairie St., and others, plan the construction of a 125 x 125 ft. hotel on San Jacinto and Masten Sts. Estimated cost $900,000. Architect not selected.

Tex., Port Arthur—The Bd. Educ., will receive bids until Jan. 27 for a 2 story, 145 x 160 ft. addition to high school, including 2 gymnasiums, machine shops, etc. and a 30 x 65 ft. boiler house, on Lake Shore Blvd.; also a 2 story, 80 x 232 ft. grade school, including auditorium, gymnasium, manual training shops, etc., on De Queen Blvd. Estimated cost $400,000 and $150,000 respectively. W. B. Ittner, 911 Locust St., St. Louis, Mo., Archt. Two oil burning boilers for steam heating will be installed in each of the above buildings. Noted Dec. 26, 1922.

Va., Ashland—Davis & Haley, are in the market for 100 hp. boiler, 75 hp. engine, fast feed moulder, Bana rip saw and 2 Excelsior mills for saw and planing mill.

W. Va., Wellsburg—The Hammond Bag & Paper Co., Box 467, is in the market for cast iron beating machinery, hangers, belting, pulleys, shafting, rotary steamers, cookers and motors, various sizes.

Wis., Green Bay—The Hotel Wisconsin Co., c/o W. Schroeder, 86 Michigan St., Milwaukee, is having plans prepared for the construction of a 9 story, 130 x 160 ft. hotel on Adams and Pine Sts. Estimated cost $900,000. M. Tullgren & Sons Co., 425 East Water St., Milwaukee, Archts. Contract for excavation and wrecking awarded to L. M. Hansen Co., 113 West Walnut St., Green Bay. Noted Dec. 12. Equipment detail not reported.

Wis., Milwaukee—Cambel Bros., 3 Grand Ave., are having revised plans prepared for the construction of an 8 story, 77 x 120 ft. and 58 x 177 ft. addition to department store. Estimated cost $800,000. H. J. Esser, 82 Wisconsin St., Archt. Contract awarded for piling, to the E. E. Gillen Co., 388 East Water St.

Wis., Milwaukee—The School Bd., F. Harbach, Secy., 10th and Prairie Sts., will soon receive bids for the construction of a 3 story, 68 x 80 ft. addition to school and a 28 x 40 ft. boiler house, on 27th Ave. Estimated cost $125,000 to $150,000. Van Ryn & De Gelleke, 114 Grand Ave., Archts.

Wis., Milwaukee—M. Tullgren & Sons Co., Archts., 425 East Water St., will receive bids until about Jan. 16 for the superstructure of a 7 story, 150 x 205 ft. theatre and office building, on Grand Ave. and 6th St. Estimated cost $1,500,000. C. W. & G. L. Rapp, 190 North State St., Chicago, Ill., Assoc., Archts. Equipment detail not reported. Noted Oct. 31.

Wis., Milwaukee—M. A. Weinries, 246 Oregon St., is in the market for two 8 x 8 x 8 and two 10 x 10 x 10 steam driven air compressors, also two 150 hp., return tubular boilers.

Wis., Portage—Columbia County Bd., is having plans prepared for a steam heating plant, including several boilers at the court house. Private plans.

Wis., Sturgeon Bay—The Door County Grower's Union, E. L. Johnson, Mgr., is in the market for additional canning and power machinery for fruit canning.

Wis., Waupaca—The city, F. A. Houseman, Clk., is receiving bids for type "Z" vertical turbine waterwheel, governor and necessary fittings, including umbrella type alternating current generator, to be installed in power house. Private plans.

Man., Winnipeg—The Pub. Utilities Com., will receive bids until Jan. 22, for the construction, delivery and erection of two 5,000 kw. alternator turbines with auxiliary equipment and one 1,000 kw. turbo alternator with auxiliary equipment, at its power house.

N. B., Fairfield—The Nashwaak Pulp & Paper Co., is in the market for turbines and other power plant machinery and equipment. Estimated cost $100,000.

Ont., Connaught—The Night Hawk Peninsular Mines, Ltd., A. R. Globe, Mgr., plans to install plant capable of handling 400 tons of ore per day, including conveyors, electric motors, shafting, rock crushers, pumps, transformers, switches, etc. Estimated cost $200,000.

Ont., Galt—The Hydro Electric Section of the Galt Pub. Utilities Comn., plans to expend $125,000 for alterations and the extension of electric distribution system and new substation equipment including wire, transformers, switches, poles, cross arms and insulators.

Ont., Kirkland Lake—The Lebell Crystal Lake Gold Mines, H. S. Rose, Pres., plan the construction of a mining plant. Motors, transformers, switches, pumps, hoisting engine, compressors and possibly diamond drills will be required.

Ont., Lansing—The Twp. of North York, H. D. Goode, Clk., is having surveys made for a street lighting system, here. Estimated cost $40,000. A Stocking, c/o Hydro Power Comn. of Ont., Hydro Bldg., Toronto, Engr.

Ont., Ottawa—The Ottawa Town Planning Comn., N. Cauchon, Chn., plans the construction of a dam above Lemieux Island in the Ottawa River to develop 30,000 hp. F. H. Plant, City Hall, Mayor.

Ont., Peterborough—The Pub. Utilities Comn., R. Hicks, Chn., has been authorized to communicate with the Hydro Electric Power Comn., and with the Ontario Government, relative to developing power at Locks No. 4 and 5 and at Burleigh Falls on the Trent Canal.

CONTRACTS AWARDED

Calif., Los Angeles—P. B. Fletcher, et al., c/o Walker & Eisen, Archts., Pacific Finance Bldg., awarded the contract for the construction of a 13 story 425 room apartment building on Kenmore Ave., to Lange & Bergstrom, Washington Bldg., about $1,000,000. Equipment detail not reported.

Calif., Merced—The Merced Irrigation Dist., awarded the contracts for furnishing 2 pumps, capacities of 12 sec.ft. and 5 sec. ft., against total head of 27 ft. to have vertical shaft with direct connected induction motors 440 volt, 60 cycle, 3 phase for Booster Plant No. 2; 2 pumps capacities of 10½ sec.ft. and 4½ sec.ft. against total head of 20.3 ft. motors 440 volt, 60 cycle, 3 phase for Booster Plant No. 3, to the Llewellyn Iron Works, 1200 North Main St., Los Angeles, $2,923 and $2,747 respectively. Noted Nov. 28.

Conn., New Haven—Yale University, J. R. Angell, Pres., awarded the contract for the construction of a 55 x 70 ft. and 50 x 60 ft. power plant on Rose St., to Thompson-Starrett, Inc., 49 Wall St., New York. Estimated cost $500,000.

Conn., Stamford—The Stamford Gas & Electric Co., 11 Bank St., awarded the contract for a 3 story switch house at its plant to the T. J. Pardy Constr. Co., 1387 Seaview Ave., Bridgeport. Estimated cost $50,000.

Ind., Crawfordsville—The city awarded the contract for the construction of a 28 ft. extension to light and power plant and 200 ft. radial stack to the Bowyer Constr. Co., Newcastle, $45,000. Equipment includes one 3,000 kw. turbine, service condenser, auxiliary, 750 hp. water tube boiler, mechanical stoker, 35 kw. exciter, 5,000 hp. heater. Noted Oct. 31, 1922.

Ind., Hammond—The Hammond Hotel & Improvement Co., 306 Hammond Bldg., awarded the contract for the construction of a 4 story, 135 x 210 ft. hotel and store building on State St., to the Finlayson Brothers Constr. Co., 139 North Clark St., Chicago, $348,000. Equipment detail not reported. Noted Dec. 19.

Mass., Boston—Coleman & Gilbert, 331 Huntington Ave., awarded the contract for the construction of a 7 story apartment building, on Gainsborough St. and Huntington Ave., to N. Hurwitz, 294 Washington St. Estimated cost $500,000. Steam heating system will be installed. Noted Nov. 14.

Mass., Brookline—Henderson & Ross, 148 State St., Boston, awarded the contract for the construction of a 10 story apartment hotel on Chapel St., to the Longacre Engr. & Constr. Co., 345 Madison Ave., New York. Estimated cost $5,000,000. Equipment detail not reported.

Minn., St. Paul—The Northern States Power Co., R. F. Pack, Vice Pres. and Gen. Mgr., 15 South Fifth St., will build a 40,000 hp. steam plant, one 35,000 kw. unit to be installed now and one later, near high bridge over the Mississippi River. Equipment has been purchased. Byllesby Engr. & Management Corp., 208 South La Salle St., Chicago, Ill., Engrs.

N. Y., Brooklyn—The Rubel Coal & Ice Corp., Glenmore Ave., will build a 2 story, 120 x 151 ft. ice plant on 18th Ave., by separate contracts under supervision of Archt. Estimated cost $500,000. Owner is in the market for ice making machinery.

Ohio, Columbus—The National Ice & Storage Co., 5th and Naghten Sts., awarded the contract for a branch ice plant to M. J. Delaney, 233 Sycamore St., about $20,000.

Pa., Phila.—The Benj. Franklin Hotel Co., c/o A. H. Mershon, Land Title Bldg., awarded the contract for the construction of a 16 story, 194 x 230 ft. hotel on 9th and Chestnut Sts., to F. W. Mark Constr. Co., Commercial Trust Bldg. Estimated cost $5,000,000. Equipment detail not reported. Noted Dec. 26, 1922.

Pa., Phila.—The Bd. Educ., 19th and Chestnut Sts., awarded the contract for the construction of a 3 story, 143 x 290 ft. high school on Musgrave St. and Washington Lane, to Melody & Sons, 1713 Sansom St., $800,000. Equipment detail not reported. Noted Nov. 28.

Pa., Phila.—The Girard Trust Co., Broad and Market Sts., awarded the contract for the construction of an 8 story bank and office building on Pennsylvania Sq. and Broad St., to the Fuller Constr. Co., Morris Bldg., $600,000. Equipment detail not reported.

Pa., Phila.—K. E. Shaparo, 5850 Market St., will build a 4 story, 150 x 250 ft. apartment building on 47th and Walnut Sts. Estimated cost $600,000. Equipment detail not reported. Noted March 21, 1922.

Ont., Dundas—The Hydro Electric Power Comn. of Ontario, F. A. Gaby, Ch. Engr., Hydro Bldg., Toronto, will rebuild substation and transformer station recently destroyed by fire, here, equipment includes 110,000 volt transformers, oil switches, arresters, insulators, switch panels, etc. Estimated cost $125,000.

Ont., Welland—The Welland Cotton Mills, Ltd., C. T. Grantham, Mgr., awarded the contract for the construction of 1 and 2 story 100 x 350 ft. cotton mills, to the Diflin Constr. Co., Main St. E. Estimated cost $250,000. Steam heating system and electric light and power will be installed. Noted July 11, 1922.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Advances—Rise of 5 per cent in rubber-covered copper wire prices, during month. White and red lead, both dry and in oil, advanced ¼c. per lb. in New York. Cotton waste up ½c. per lb. in Cleveland. Babbitt metal rose 3c. in New York and 1½c. per lb. in Cleveland, since last month. Tendency higher in finished steel products, following advances in coke, and iron and steel scrap. Fire, air and steam hose, and rubber belting discounts firm.

Declines—Structural and boiler rivets, down 15c. per 100 lb. at mill, during month. Reduction of $3 per M. in silica brick at Chicago. Clay brick, declined 50c. per M. in Pennsylvania, Ohio and Kentucky districts.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in., coupled		45c. per ft.
Common, 2½-in., 3-ply	1.00 per ft. list less 50%	

	Air	
	First Grade	Second Grade
¾-in., 3-ply, per ft.	$0.31	$0.22½

Steam—Discounts from List

First grade....40–10–5% Second grade....50 Third grade....50–10

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 65% Best grade..... 60%

LEATHER BELTING—List price per ply, 12-in. wide, per lin. ft. $2.88

Grade	Discount from list
Medium	30–10%
Heavy	20–5–2½%

RAWHIDE LACING
For cut, best grade, 40%, 2nd grade, 50%.
For laces in sides, best, 48c. per sq.ft.; 2nd, 43c.
Semi-tanned: cut, 40%; sides, 48c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ⅛ in	$0.90
Asbestos for high-pressure steam, ½ in.	1.80
Duck and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.90
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.70

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		40@45% off
For low-pressure heating and return lines	4-ply	60% off
	3-ply	62½% off
	2-ply	65% off

PORTLAND CEMENT—New York, $2.60@$2.70 per bbl. without bags, in cargo lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.14 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York Current	Cleveland	Chicago
White	9.00@11.50	12.50	11.25
Mixed	6.50@10.00	9.50	8.00

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13¼ x 13¼	13¼ x 20½
Chicago	10.00	13.00
New York	16.00	20.00
Cleveland	$32.00 per M.	$48.00 per M.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.93	$1.01	$0.98

WHITE AND RED LEAD—Base price in cents per pound:

	Red				White			
	Current		1 Year Ago		Current		1 Yr. Ago	
	Dry	In Oil	Dry	In Oil	Dry or In Oil	In Oil	Dry or In Oil	In Oil
100-lb. keg	13.50	15.00	12.25	13.75	13.50		12.25	
25- and 50-lb. keg	13.75	15.25	12.50	14.00	13.75		12.50	
12½-lb. keg	14.00	15.50	12.75	14.25	14.00		12.75	
5-lb. cans	16.50	18.00	15.25	16.75	16.50		15.25	
1-lb. cans	18.50	20.00	17.25	18.75	18.50		17.25	

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	45%	60%	60%
Tinned	50%	60%	4½c. per lb. net

Structural rivets, ¾, ⅞, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb

New York....$3.85 Chicago....$3.75 Pittsburgh....$3.00

Boiler rivets, same sizes:

New York....$3.95 Chicago....$3.85 Pittsburgh....$3.10

REFRACTORIES—Prices in car lots:

Chrome brick, eastern shipping points	net ton	$50@55
Chrome cement, 40@50% Cr_2O_3	net ton	27@30
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	31@34
Magnesite brick: 9-in. shapes	net ton	70@75
Magnesite brick: 9-in. arches, wedges and keys	net ton	77@82.50
Magnesite brick: Soaps and spits	per ton	98@105
Silica brick: Chicago district	per M	48@50
Silica brick: Birmingham, Ala.	per M	50@53
Silica brick: Mt. Union, Pa.	per M	45@47
Clay brick, 1st quality, 9-in. shapes, Missouri	per M	40@45
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	35@40
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	35@40
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	35@40
Clay brick, 2nd quality, 9-in. shapes, Missouri	per M	30@35
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	26.50@28.50
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	26.50@28.50
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	26.50@28.50
Chrome ore crude, 45@50%	net ton	20@22
Magnesite dead burn	net ton	24.00

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	42.00	48.50	36.00
(35% tin)	25.00	17.50	.....

COLD FINISHED STEEL—Warehouse prices are as follows:

	New York	Chicago	Cleveland
Round shafting and screw stock, per 100 lb. base	$3.90	$3.70	$3.75
Flats, square and hexagons, per 100 lb. base	4.40	4.20	4.25

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	55%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	66	54½	¼ to 1¼	34	19

LAP WELD

2	59	47½	2	29	15
2½ to 6	63	51½	2½ to 4	32½	19
7 to 8	60	47½	4½ to 6	32½	19
9 and 12	59	46½	7 to 12	30	17

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	64	53½	¼ to 1½	34	20
2 to 3	65	54½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	57	46½	2	30	17
2½ to 4	61	50½	2½ to 4	33	21
4½ to 6	60	49½	4½ to 6	32	20
7 to 8	56	43½	7 to 8	25	13
9 to 12	50	37½	9 to 12	20	8

BOILER TUBES—Following are prices in New York wareh use of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$0.23
1¼	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
2	.20	.25	.21
2¼	.23	.29	.23
2½	.24	.33	.28
2¾	.....	.....	.....
3	.30	.41	.32
3½	.32	.47	.35
3½	.34	.51	.37
4	.43	.64	.47

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net per lineal foot based on stock lengths. If cut to special engths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:
1¼ in. to 2 in. diameter, 5c. per cut. 2¾ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 44.00 (net)	$59.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	35%	20%
Coils to 1,000 ft.	40%	25%
1,000 to 5,000 ft.	45%	30%
5,000 ft. and over	50%	35%

CONDUIT, Price per 1,000 ft.: **ELBOWS AND COUPLINGS**, Per 100 pieces, f. o. b. New York, with 10-day discount of 5 per cent.

Size, In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplgs Black Per C	Couplgs Galvanized Per C
¼	$55.59	$60.69	$9.96	$11.11	$4.52	$4.88
⅜	55.59	60.69	9.96	11.11	5.28	5.70
½	70.61	77.51	13.10	14.60	7.54	8.14
1	100.98	111.18	19.39	21.61	9.80	10.58
1¼	136.62	150.42	25.83	28.53	13.67	14.69
1½	163.35	179.85	34.44	38.04	16.88	18.14
2	219.78	241.98	63.14	69.74	22.51	24.19
2½	347.49	382.59	103.32	114.12	32.16	34.56
3	454.41	500.31	275.52	304.32	48.24	51.84
3½	574.08	629.28	608.44	672.04	64.32	69.12
4	701.96	767.36	703.15	776.65	80.40	86.40

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.08	D. P. D. B.	$0.26
D. P. M. L.	.13	T. P. S. B.	.25
T. P. M. L.	.19	T. P. D. B.	.38
D. P. S. B.	.15		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp
D. P. M. L.	$0.38	$1.20	$1.25
T. P. M. L.	.53	1.40	1.80
D. P. S. B.	.47	1.20	.....
T. P. S. B.	.88	2.00	.....
D. P. D. B.	.85	2.35	.....
T. P. D. B.	1.50	4.00	.....
T. P. to D. P. D. B.	1.00	2.75	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$19.95
No. 16 cotton reinforced heavy	26.15
No. 18 cotton reinforced light	17.33
No. 16 cotton reinforced light	21.50
No. 18 cotton Canvasite cord	14.70
No. 16 cotton Canvasite cord	17.06

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$.20	3-amp. to 30-amp.,	100	$0.40
35-amp. to 60-amp.,	100	0.30	35-amp. to 60-amp.,	100	.60
65-amp. to 100-amp.,	50	2.90	65-amp. to 100-amp.,	50	1.50
110-amp. to 200-amp.,	25	3.00	110-amp. to 200-amp.,	25	2.50
225-amp. to 400-amp.,	25	5.60	225-amp. to 400-amp.,	25	5.50
425-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package	$2.50
0–30 ampere, less than standard package	2.85

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs — Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.40	100	75	$0.60	$0.65	50
15	.35	.40	100	100	.75	80	24
25	.35	.40	100	150	1.00	1.10	24
40	.35	.40	100	200	1.30	1.40	24
50	.35	.40	100	300	1.90	2.00	24
60	.40	.45	100				12
				500	2.75	2.90	12
				750	4.00	4.25	8
				1,000	4.50	4.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.17
Composition 2-piece attachment plug	.26
Swivel attachment plug	.12

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 6.62	$ 8.40	$10.52	$16.75
12	9.15	11.13	13.16	21.88
10	12.00	13.73	16.75	28.44
8	16.14	18.80	22.10	38.03
6	.....	.....	33.40	.....
4	.....	.....	45.00	.....
2	.....	.....	68.23	.....
1	.....	.....	91.17	.....
0	.....	.....	113.16	.....
00	.....	.....	134.28	.....
000	.....	.....	161.34	.....
0000	.....	.....	192.88	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap — Key Each	Keyless Each	Pull Each	¾ In. Cap — Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package	15%
1-5th to standard package	27%
Standard package	42%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c. lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	21c. lb
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	25%
$25 to $50 list value	30%
$50 list value or over	35%